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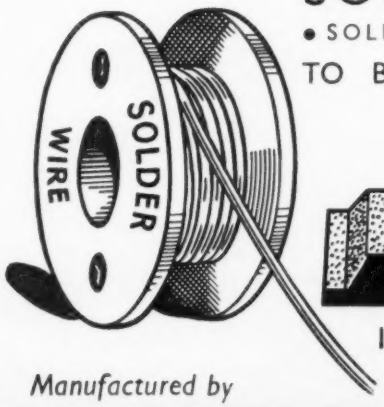

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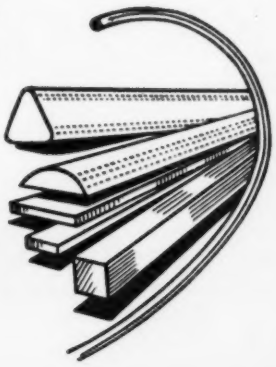

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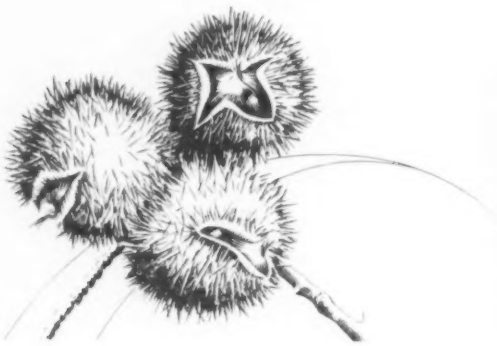

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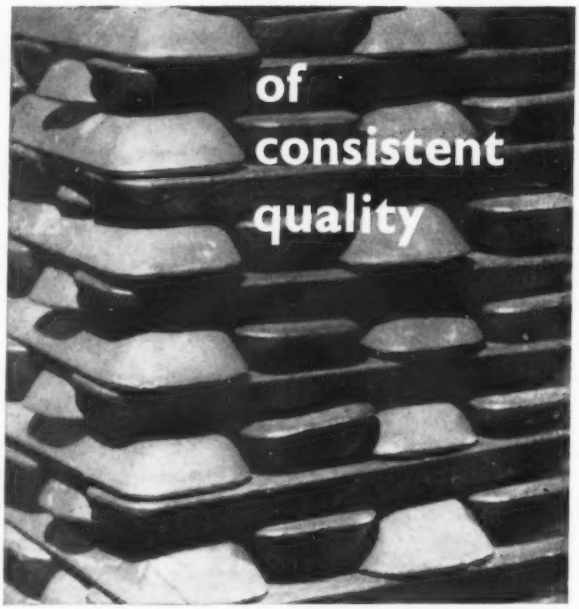

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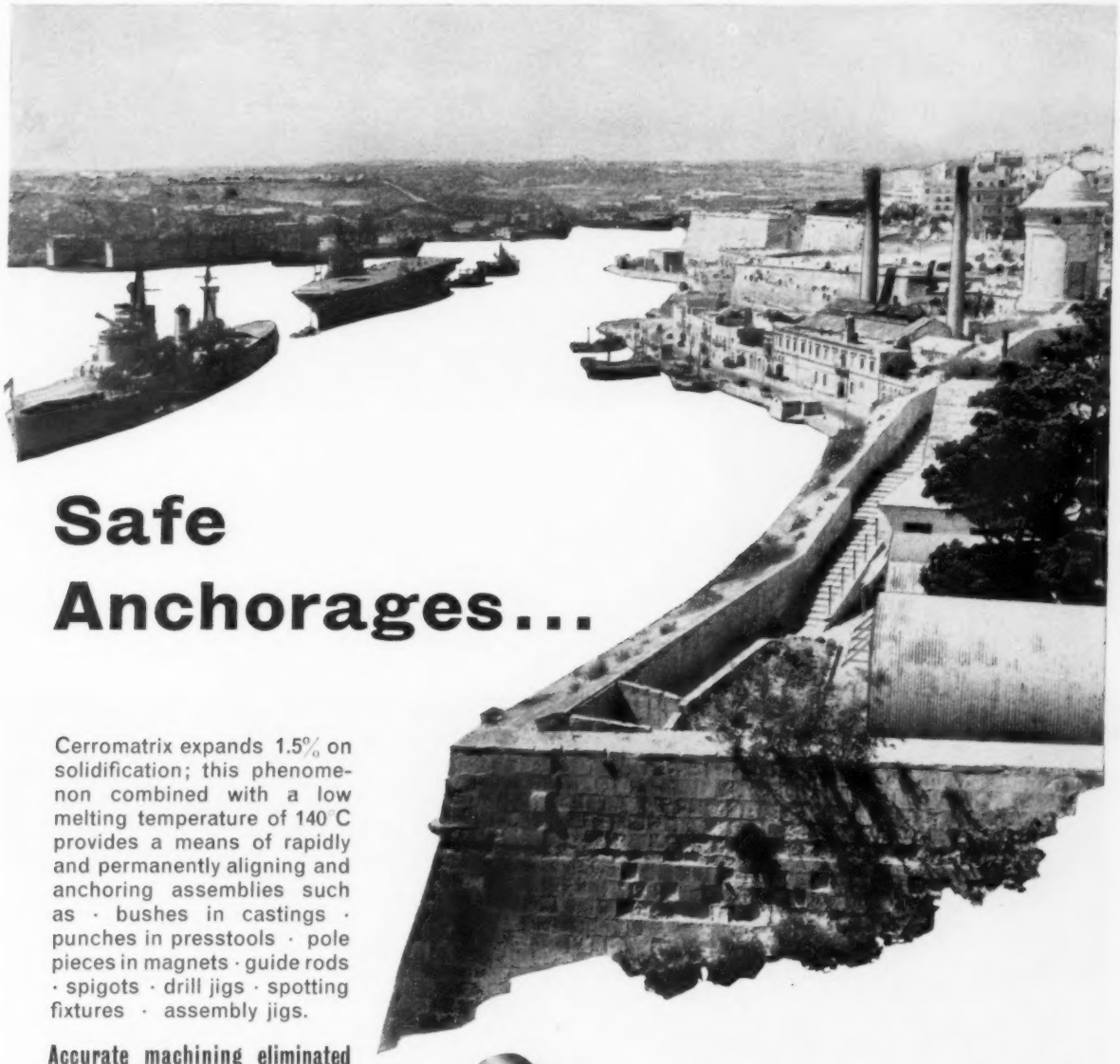

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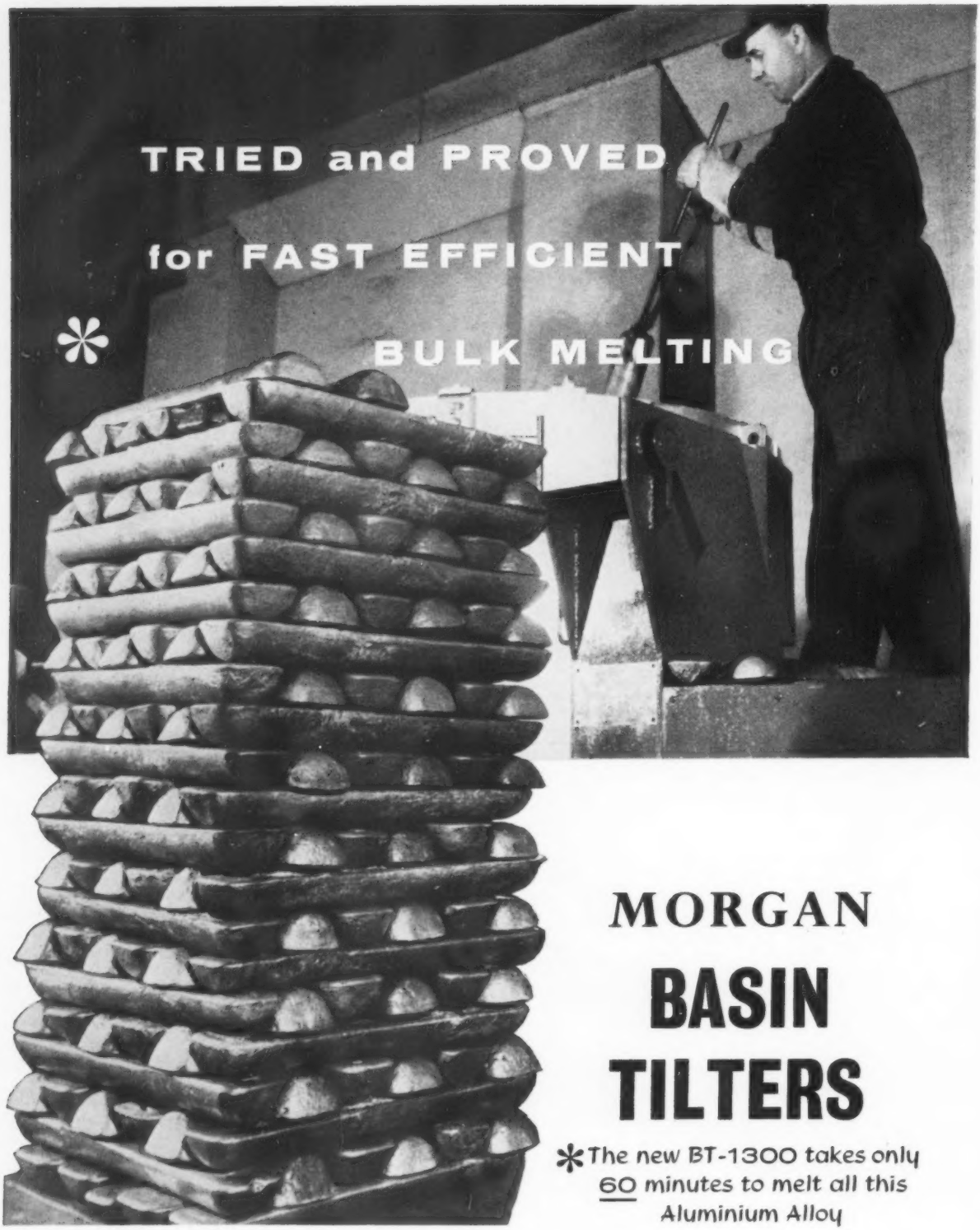

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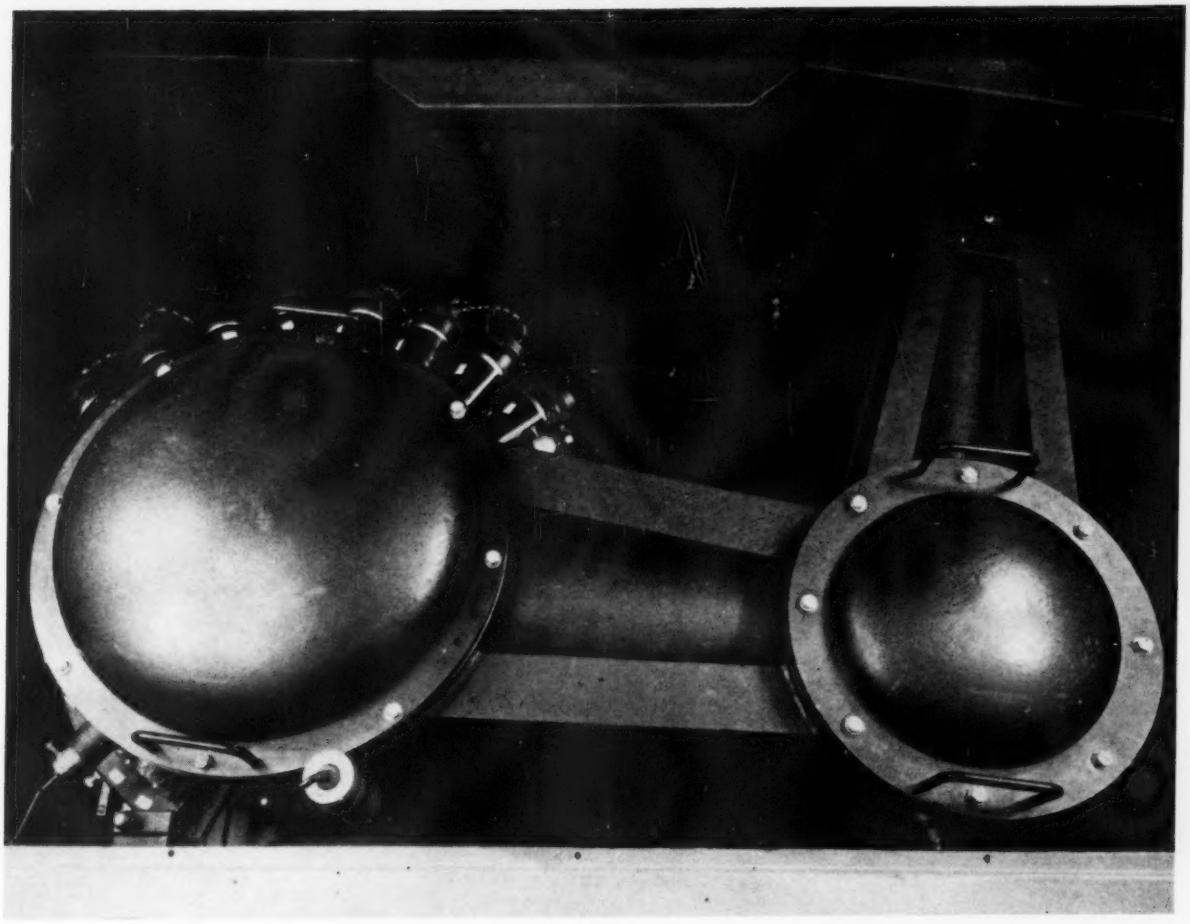

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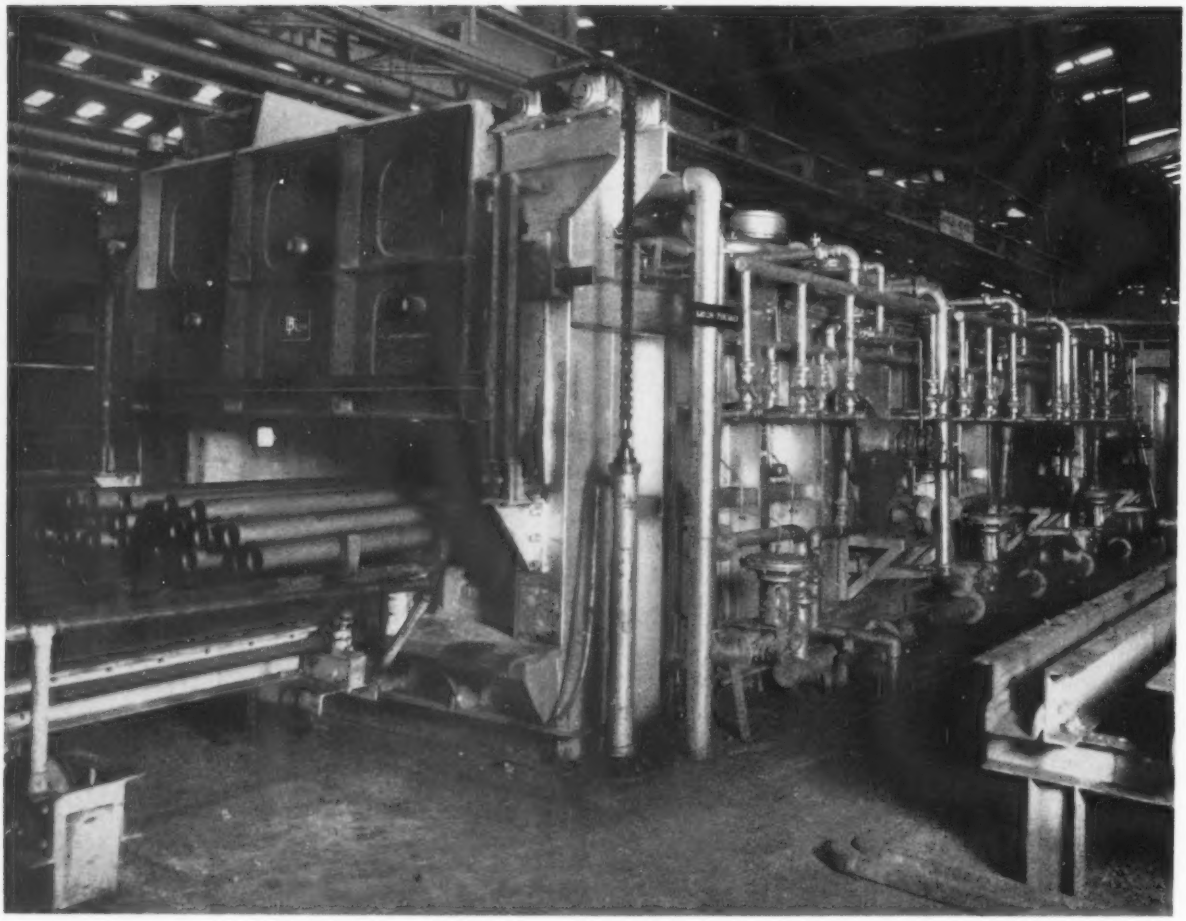

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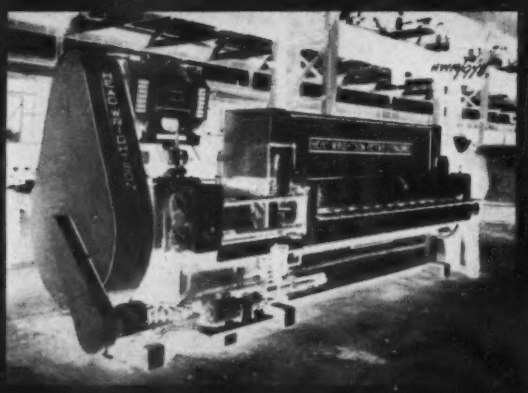

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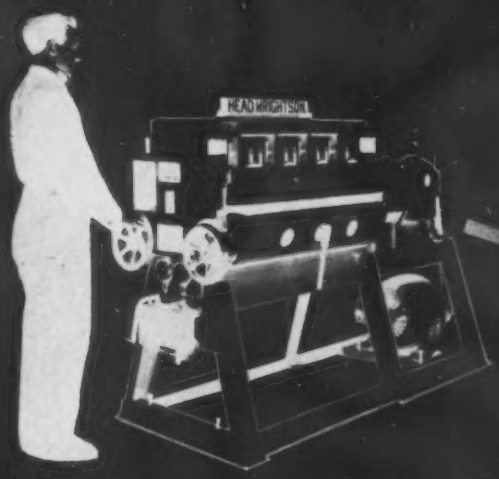
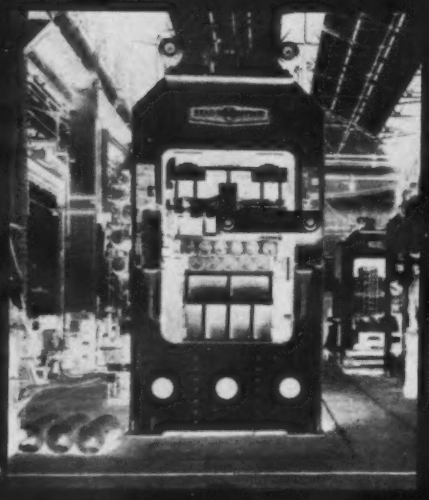
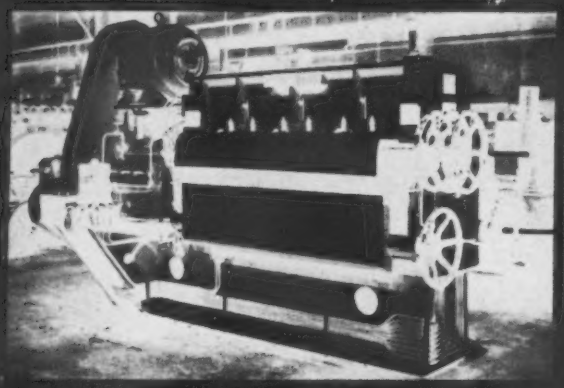


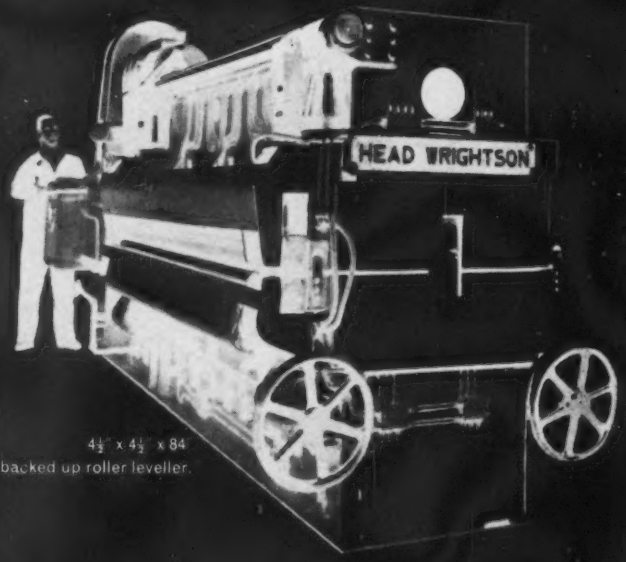
$3\frac{1}{2}$" x $3\frac{1}{2}$" x 60" Pressure regulating roller leveller with pinch rolls.



Three heavy plate levellers capable of levelling plate 12ft wide by 2 inches thick being built at the company's works.



$1\frac{1}{4}$" x $1\frac{1}{4}$" x 54" Pressure regulating roller leveller.



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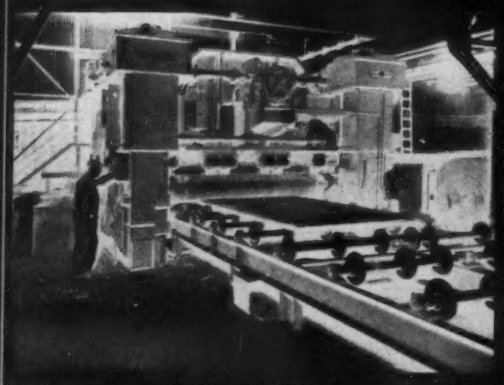

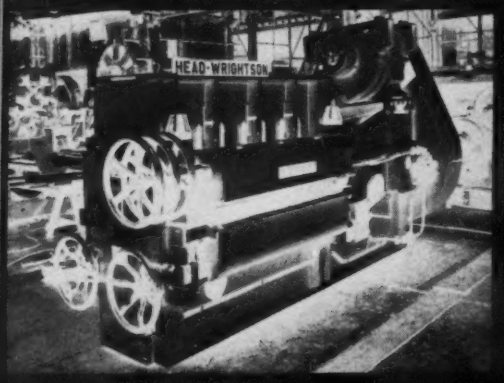

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5 MAY 1961 VOLUME 98 NUMBER 18

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In some cases the existing procedure of a producer is accepted as the best practice of the art and is taken as a basis for the standard in question. Thus British Standard 1004 (Zinc Alloy for Die Casting) was based on the established practice of the Imperial Smelting Corporation in the production of Mazak.

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METAL INDUSTRY

VOLUME 98 NUMBER 18 5 MAY 1961

Fire Prevention

MANY thousands of pounds are lost every year to industry and to the country generally by outbreaks of fires. Every year some 700 people are killed by fire and many thousands more suffer injury and disfigurement, by far the greatest number of victims being women and children and the elderly. Property losses last year were estimated at £43,769,000, as compared with a record figure of just over £44 million in 1959. More than one disastrous fire has taken place in the metal-working industries, resulting in the loss of a good deal of valuable machinery and buildings, as well as, in some cases, lives.

This year, action committees are being set up under the guidance of fire authorities in local areas to organize a National Fire Prevention week from October 30 to November 4. Sponsored jointly by the Fire Protection Association and the Royal Society for the Prevention of Accidents, appeals have been made to private and nationalized industries, the Armed Services and Government Departments, as well as voluntary and welfare organizations, to co-operate in making this special week a success. Plans are already under way for an intensive publicity drive to spotlight the dangers and causes of fire and to give advice on fire prevention in the factory, the shop, office and the home.

This campaign against fire dangers has the support of the Home Office, the Scottish Home Department and the Ministry of Labour, but its success will depend largely on local effort and initiative, and, of course, the help of the industrial world. For this reason the sponsors have sought the practical knowledge and active assistance of the fire authorities to organize the campaign in their own areas. The action of Fire Prevention Week committees will be the key. It is anticipated that they will also co-operate closely with home safety committees and industrial accident prevention groups. Fire prevention exhibitions and displays will, it is hoped, be a feature of this special event, and special short films for television and cinema are being made by Government Departments. There will also be lectures by fire officers at schools, factories, etc. It is to be hoped that industrialists will see to it that all engaged in safety work at their factories and works, where an outbreak of fire can have such far-reaching results, are encouraged to take the opportunity that this week will provide of learning how to deal with the many dangers which arise from fires, or, more important still, the opportunity to learn how to prevent such outbreaks.

Out of the MELTING POT

Theoretical Clarity

UNFORTUNATELY, the process of fracture of a real polycrystalline metal specimen under a tensile stress is very far removed from the phenomenon of crack propagation in an ideal crystal considered by theory. In spite of the difference between the two, however, the theoretical approach is not without value, if only as a training in clear thinking. On a broader view, of course, the theoretical approach serves to set the limits between the possible and the impossible or, at any rate, between the probable and the improbable, within which limits modifications can then be effected to meet the demands of a situation as it is encountered in real life. In this matter of fracture, an exercise adopting the theoretical approach has led to the conclusion that although the configuration of an ideal crystal, subjected to a tensile stress and containing a crack, corresponds at any given time to a minimum potential energy, there is nothing to stop the crack, once formed, from propagating throughout the crystal with a velocity of the order of that of sound. Propagation of the crack cannot be stopped by the forces of cohesion between the atoms; it can be hindered only by distortion of the crystal lattice. A crack of this kind constitutes a purely elastic formation, in the sense that if the external stress is removed, the crack will close up. The fact that in real solids, brittle fracture is not observed, means that fracture does not occur as a result of the propagation of an elastic microcrack. If it is assumed that stress concentration is caused by a stable crack, the existence of such a crack presupposes the existence of an already distorted lattice. Plastic deformation must occur first, and only afterwards can a stable crack make its appearance.

Fundamental Waste

FUNDAMENTAL principles are either taken for granted as obvious, overlooked, or allowed to pass unrecognized. In instances in which the latter is allowed to happen, it is then faintly amusing to note the near-surprise with which the results of the operation of such unrecognized principles are subsequently greeted. The atomic energy programme, which was embarked upon with a haste that left little time for consideration of few fundamental principles other than those governing the operation of the process itself, provides one or two examples of the more or less unexpected emergence of consequences of the other unrecognized principles. The failure to recognize one of these principles can perhaps be excused on the grounds that its recognition can best be achieved through a comparison of two such widely different undertakings as the generation of atomic energy and pork canning. Such a comparison, made on the basis of what is utilized and what products and by-products are obtained, leads to the fundamental principle according to which the more commonplace or down-to-earth that which is being utilized, the fewer the by-products. In pork canning, the pigs are certainly pretty commonplace and down-to-earth, and the only by-product, accordingly, is the proverbial squeal. In the generation of nuclear power, the fission process producing the energy borders on the esoteric: it is almost as if only the squeal was being used. The result is that, in accordance with the above principle, there is left a mass of intractable by-products ranging from radioactive waste to, ultimately, one gathers, the nuclear power stations themselves, once they have outlived their usefulness while remaining too hot to dismantle. Indeed, natural uranium itself, on which the whole nuclear power enterprise is based, has also recently reached the status of something very like a by-product for which, as is customary in the case of by-products, uses are being sought with, as is also customary, little success. The recent announcement of the development of a uranium alloy steel can hardly be classed as one. So much for unrecognized fundamental principles and their consequences.

Widening The Scope

A DEVELOPMENT of recent years that still awaits further extension is the production of materials of very high purity and the study and utilization of the properties that such materials possess. While the production and use of ultra-high purity materials has so far been largely restricted to the field of electronic devices, where the need for them is imperative, the introduction of analogous techniques into other fields appears to be well worth investigating, even in the absence of any immediately foreseeable, though certainly not the possibility of unexpected, results. Fields into which such extensions could be undertaken might include, for a start, casting, powder metallurgy and, last but not least, surface treatment, in particular electroplating. In connection with the latter, it is indeed surprising that in view of the considerable body of evidence regarding the marked effects of minor constituents and impurities in plating solutions, experiments with solutions of high purity have so far been few and far between. One reason for this is probably the failure to appreciate the possible sources of significant impurities in such experiments. The need to use high purity compounds is self-evident. Thus, in a recent investigation into the electrodeposition of zinc and manganese from extremely pure solutions, the zinc sulphate was prepared from zinc which had been distilled in nitrogen and had a total impurity content of 10^{-5} per cent, and redistilled sulphuric acid. Less obvious was the need to remove organic compounds from the distilled water used to make up the solution. This was achieved by boiling the water with potassium permanganate solution, and then redistilling it three times, each time discarding the first third of the distillate. From the resulting high purity zinc sulphate solution (60 gm/L zinc, 100 gm/L sulphuric acid) it was possible, at 20°C., to deposit zinc with current efficiencies of about 60 per cent at current densities of up to 1 amp/m^2 and up to 99 per cent at 5 amp/m^2. The deposits consisted of large crystals with regular, mirror-smooth faces. The shape of the grains became irregular and their size diminished as soon as impurities were introduced into the solution (e.g. by water from which organic compounds had not been removed, or by contact of the solution with parts made of vinyl, polyethylene, or even p.t.f.e. plastics). In the case of a manganese-ammonium chloride solution of high purity, it was found possible to deposit manganese at current densities as low as 10 amp/m^2 (at 20°C.) and to obtain current efficiencies of 90-93 per cent at higher current densities (660-2,000 amp/m^2).

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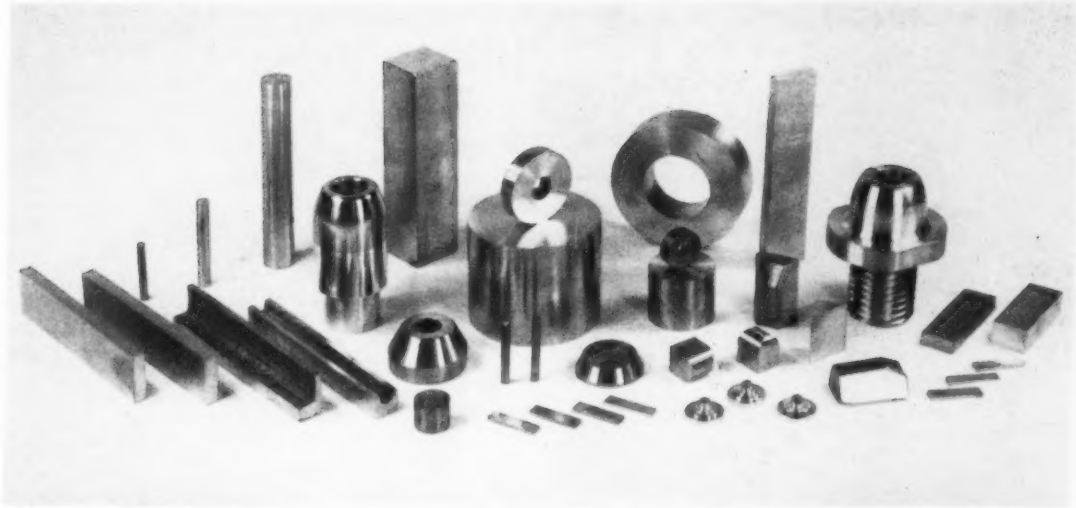


Sintered "Heavy Alloy" components [*Courtesy The General Electric Company Ltd. of England*

Powder Metallurgy - A Survey

By I. JENKINS, D.Sc., F.I.M.

Outlining the principles as well as the practice of powder metallurgy, this survey discusses the manufacture of powders, composition, sintering and applications. In its original form it was given at a Conference organized by the Birmingham Productivity Association.

POWDER metallurgy includes the manufacture of metals in the form of powder and the conversion of the powder into ingots or finished shapes by the application of pressure and heat, such that the metal particles bond together below the melting point of the major constituent to form a coherent solid mass. The powder can be that of a metal, an alloy, a metal compound, a non-metallic substance, or a mixture of any of these.

The powder is introduced into a mould of the required form, pressed and compacted (Fig. 1), and mainly through mechanical interlocking of the particles, a coherent pressing is produced. This is then heated in a furnace, either in a vacuum or an atmosphere, the composition of which is controlled to ensure that oxidation or any other undesirable reaction does not occur. The powder particles sinter together; the voids which were not eliminated by the initial compaction of the powder are reduced in volume, and in some cases, almost completely eliminated; and the compact shrinks (Fig. 2).

The choice of sintering conditions will be determined by the characteristics of the metal powder and by the properties required in the product. Where good mechanical properties are required, it is desirable to produce a sintered body as free as possible from porosity (Fig. 3); for pure metals, this involves sintering at a temperature close to the melting point. If an alloy consists of metals of widely differing melting points, a mixture of powders of both metals may be sintered above the melting point of one but below that of the second metal (Fig. 4). This so-called "liquid phase" sintering accelerates considerably the densification process and yields a material with very low porosity. Alternatively, the higher melting point constituent may be sintered first to produce a coherent sponge-like body, which is then brought into contact with the second metal, which is molten (Fig. 5). The latter will then be absorbed into the pores of the first—a process known as "infiltration". Both the latter processes may be used to make mixtures of metals which do not alloy with each other, e.g. tungsten - copper, tungsten - silver, carbon-copper, etc. In certain cases, the value of the sintered product depends upon a controlled residual and interconnected porosity which is subsequently filled with oil, as in the manufacture of self-lubricating bearings (Fig. 6).

The primary fields of application of powder metallurgy may be grouped as follows:

(a) The manufacture of metals or alloys which cannot be produced by melting and casting (e.g. tungsten, tantalum, sintered carbides and heavy alloys).

(b) The manufacture of components either from metals which do not alloy (e.g. copper-lead bearings, tungsten-copper and tungsten-silver contacts, copper-carbon brushes, etc.); or which have some specific requirement such as porosity (e.g. porous bearings, filters and "sweat-cooling" devices).

(c) The manufacture of alloys to precise compositions and having properties which fall within narrow specification limits (e.g. alloys for sealing to glass and ceramics, magnetic materials,

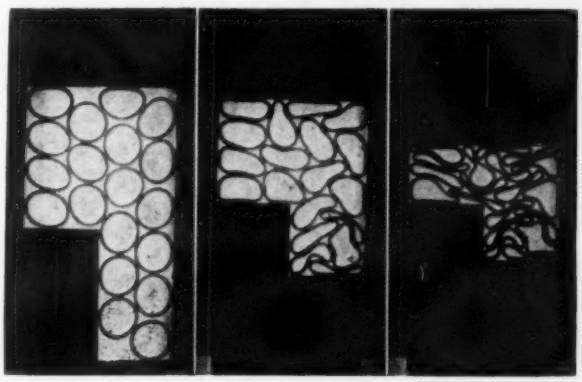
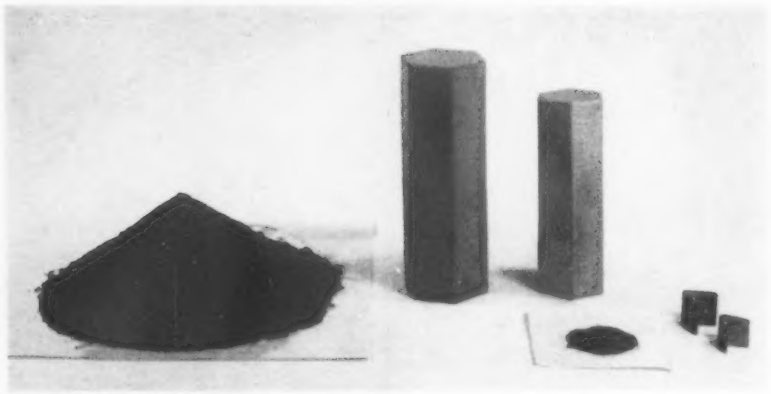
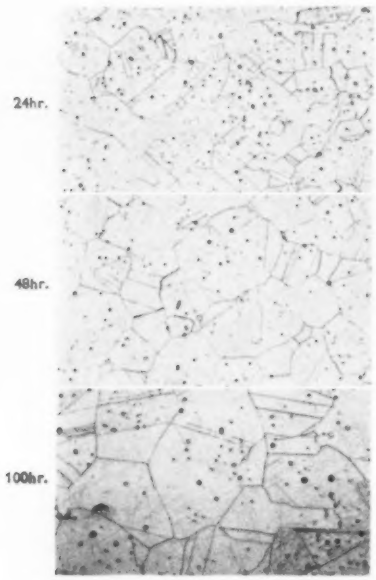


Fig. 1—Diagrammatic representation of the compaction of a powder in a die



Above: Fig. 2—Metal powder, pressed compact and sintered body showing stages in reduction of volume



Right: Fig. 3—Porosity in nickel bar after sintering for the period indicated at 1,300°C.

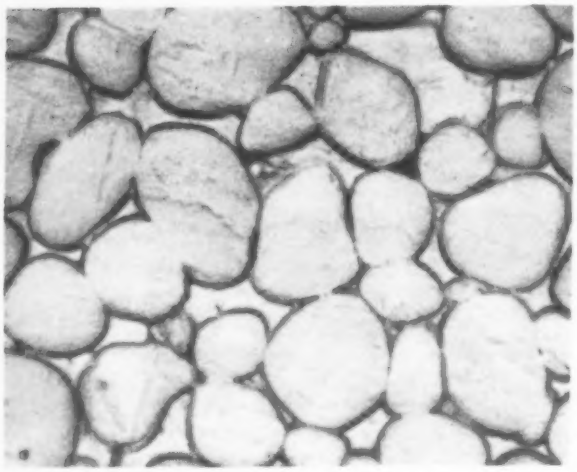


Fig. 4—Sintered tungsten-nickel-copper alloy (x 500)

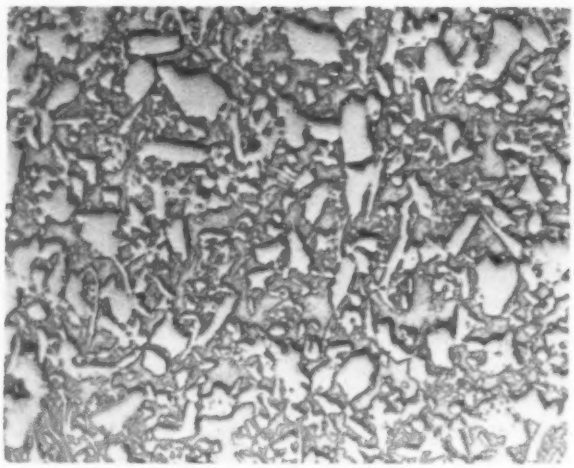


Fig. 5—Structure of tungsten, infiltrated with copper

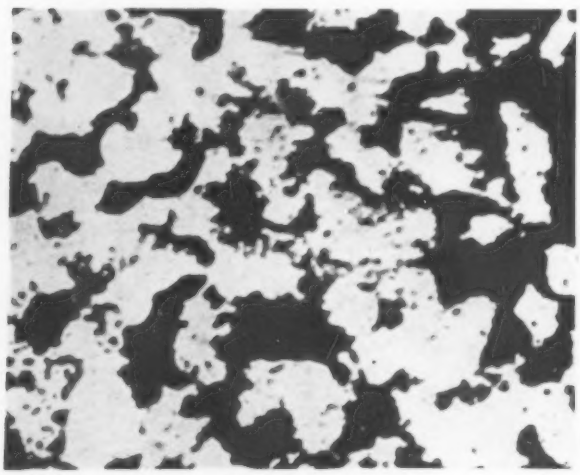


Fig. 6—Structure of a high porosity porous bronze bearing (x 400)
[Courtesy Bound Brook Bearings Ltd.

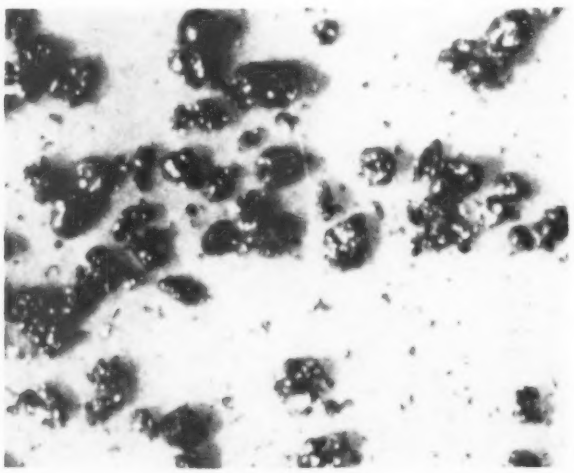
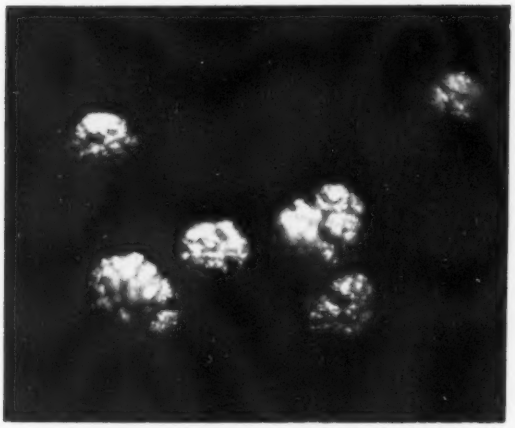


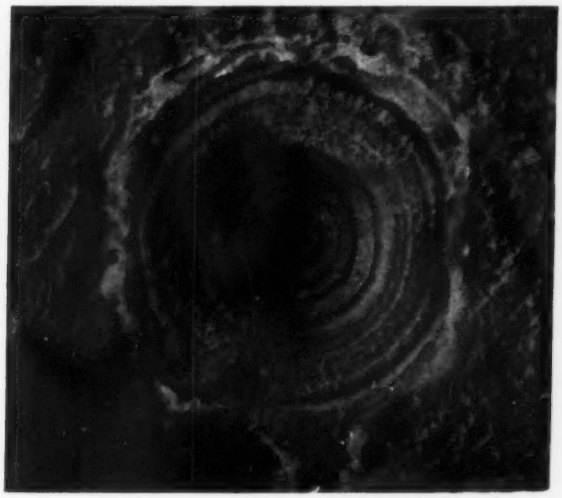
Fig. 7—Swedish sponge iron powder (x 40)
[Courtesy Höganäs-Billesholms A.B.



[Courtesy Mond Nickel Co. Ltd.

Above: Fig. 8—Nickel powder precipitated hydrothermally from aqueous solution (x 60)

Right: Fig. 9—Section through a nickel particle produced by the carbonyl process (x 20,700 reduced by $\frac{1}{4}$)



[Courtesy Mond Nickel Co. Ltd.

high temperature alloys, and bimetallic elements). These materials may, if necessary, be hot or cold worked after sintering.

(d) The mass manufacture of engineering components direct to finished shape and size without final machining.

The powder metallurgy process can be sub-divided as follows: (1) the manufacture of powders; (2) control and standardization of powders; (3) compacting; (4) sintering.

Manufacture of Metal Powders

There are many methods which can be used for making metal powders, each resulting in particles having their own characteristics in respect of shape, density, and distribution of sizes. Furthermore, the powder particle may be dense, porous or hollow, and may be spherical, flattened, angular or dendritic. The primary production processes may be listed as follows: (i) reduction of oxides; (ii) gaseous reduction of aqueous solutions; (iii) thermal dissociation of metal compounds; (iv) electrolysis; (v) atomization.

Metals, such as iron, copper, tungsten and molybdenum which form oxides readily reduced by hydrogen or carbon, are produced in powder form by reduction of the corresponding metal oxide. Swedish sponge-iron powder, which is used extensively in ferrous powder metallurgy (Fig. 7), is produced by the carbon-reduction of the rich Swedish iron ores. The gaseous reduction of aqueous solutions is confined to treatment of ore concentrates of copper, nickel and cobalt, the metal being precipitated from solution by high pressure hydrogen (Fig. 8). The thermal dissociation process is restricted on a commercial scale to nickel and iron, which are first converted to gaseous carbonyls (Fig. 9); these are then dissociated at a suitable temperature and pressure, back to the metal powder. Electrolysis opens up greater scope in that most metals can be electrolyzed from solution satisfactorily (Fig. 10), including materials of growing importance such as tantalum and beryllium, but perhaps the most significant development in recent years has been that of atomization. Basically, this consists of forcing a molten metal through an orifice and breaking up the stream with a high pressure jet of gas or water. If necessary, an inert atmosphere can be employed (Fig. 11). The particles of metal formed solidify rapidly and, although the atmosphere may be air, only superficial oxidation takes place. The importance of this process is related not only to the great variety of metals and alloys to which it can be applied, including those of

Fig. 10—Electrolytic iron powder (x 40)

[Courtesy Husqvarna A.B.

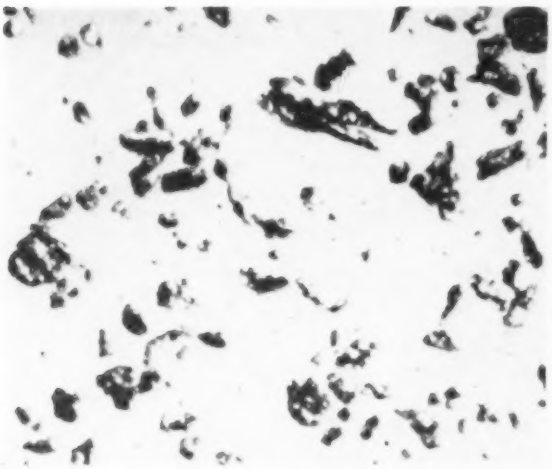
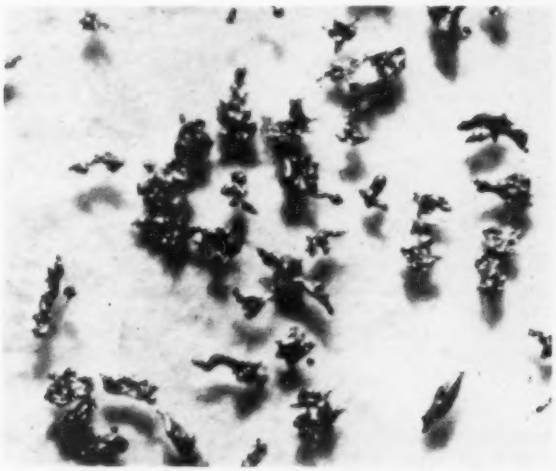
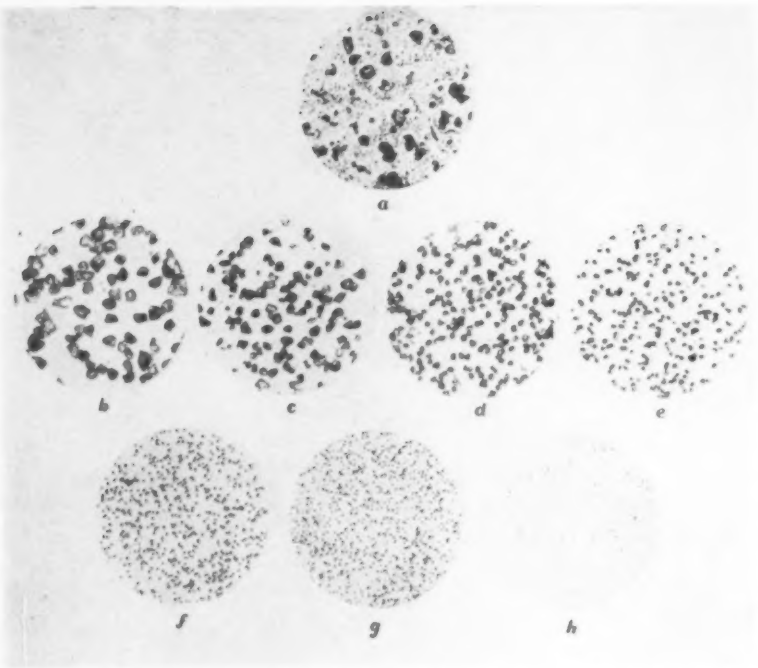


Fig. 11—Atomized nickel alloy powder (approx. x 40)

[Courtesy B.S.A. Metal Powders Ltd.





a—Original powder. b—Cone I, weight 13·1 per cent, size about 45-90μ. c—Cone II, weight 20·3 per cent, size about 40μ. d—Cone III, weight 13·0 per cent, size about 27μ. e—Cone IV, weight 10·5 per cent, size 20μ. f—Cone V, weight 9·9 per cent, size about 13μ. g—Cone VI, weight 10·3 per cent, size about 8μ. h—Filter bag, weight 23·0 per cent, size less than 5μ.

Fig. 12—Particle size ranges in a ball-milled metal powder (x 100). Fractionation using the Haultain Infrasizer

very high melting point, but also to the fact that it yields a good quality powder, at a competitive price.

Control and Standardization

The physical and chemical properties of a metal powder determine its behaviour during subsequent compaction and sintering. It is, therefore, necessary to measure the properties of powders with satisfactory accuracy, and the most important are the following: (i) particle size and distribution; (ii) specific surface and particle density; (iii) particle shape; (iv) chemical properties; (v) packing and moulding properties.

The magnitude of the standardization problem can be appreciated, for example, by the range of particle sizes which may be obtained in a batch of powder (Fig. 12).

The methods used for measuring the properties of metal powders often involve principles employed in other branches of science or technology. It is not proposed to describe the various methods in detail, but obviously the microscope (both optical and electron) is important in studying particle shape, particle size and size distribution. The specific surface is derived from the permeability of a bed of powder to air or other gases; it can be obtained also by determining the adsorption of an inert gas such as nitrogen at sub-zero temperatures. Chemical properties may be examined by conventional means; the determination of surface contamination of a powder by oxygen or other impurities may be of particular importance. The packing and moulding properties of powders are important because the volume occupied by a given weight of powder in the uncompacted state determines the extent to which it has to be compressed in a die and this determines the stroke of the press. Generally speaking, powders of high specific density involving short compressing distances are to be preferred in mass production.

(To be continued)

Ferrous Alloys

INTENDED as a guide to the effects of elements introduced into both steel and cast iron, a book entitled "Constituent Elements in Steel and Cast Iron" has been published by London and Scandinavian Metallurgical Co. Limited. The benefits obtained by the addition of some 29 constituent elements are outlined, together with the purpose of their addition, and details of the consequent effects upon physical and mechanical properties are briefly given. For simplicity of reference the elements are arranged alphabetically. The book is a revised and enlarged edition of a similar one published some years ago. This edition, which has 79 pages and a Periodic Table, is available at 10s. 6d. from the company at 39 Wimbledon Hill Road, London, S.W.19.

Alloy Structures

A TECHNIQUE for producing extremely rapid rates of cooling of metal systems has been developed at the California Institute of Technology, Pasadena.

The classical method for achieving high rates of cooling consists of injecting a small droplet of molten alloy into a liquid quenching bath. The cooling, accomplished by transfer of heat from the alloy to the bath, is slowed by a gaseous layer between alloy and liquid caused by evaporation of the quenching liquid.

The new technique avoids this limitation by replacing the liquid bath with a solid wall made of a good heat conductor. To accomplish rapid cooling, the liquid alloy must strike the cold surface at high speed in order to spread the liquid into a thin layer, and a good contact must be assured between the liquid alloy and the target conductor. A small liquid droplet (about 25 milligrams) was propelled by means of a shock wave against the inside surface of a high speed rotating cylinder of solid copper. The centrifugal force of the rotation, acting on the molten alloy, ensured a good thermal contact with the copper target, and also helped in spreading the liquid alloy over a larger area to assure a large heat transfer rate.

This technique permits small amounts of liquid alloys to be cooled to room temperature or below at rates high enough to prevent the normal process of nucleation and growth of equilibrium phases. The structure of these alloys is different from that normally obtained and their properties are unusual. Since these alloys are metastable, the effect of radiation on their structure will be quite drastic. They are obtained in the form of foils about 10 to 15 microns thick, and are ideally suited for studying the effect of electron irradiation on the structure of alloys.

The method was first applied to alloys of silver and copper, which normally form a eutectic. Under fast cooling conditions, the two metals were formed into a solid solution. This result was predicted on the basis of certain criteria for the existence of complete miscibility between two metals. The rapid cooling technique was then applied to silver-germanium alloys. In this system, normally a eutectic type, complete miscibility is precluded by dissimilar crystal structure. After rapid cooling from the melt, a new compound of the approximate composition Ag_3Ge (silver germanium) was discovered.

It has been found that under certain conditions some alloys can be quenched fast enough from the molten state to retain a quasi-liquid structure. Such alloys could be studied in the solid state and thereby provide a greatly simplified experimental approach to studying the structure of liquids.

Men and Metals

At the annual general meeting of the Association of Light Alloy Refiners and Smelters Limited, held a few days ago, **Mr. W. W. Kee** (Alcan Enfield Alloys Limited) was re-elected chairman, and **Dr. J. Jakobi** (International Alloys Limited) was elected vice-chairman, to hold office until the end of the next annual general meeting. The council of management for the same period consists of the chairman, the vice-chairman and the following members: **Mr. F. Farenden** (The Eyre Smelting Company Limited), **Mr. R. Hahn** (B.K.L. Alloys Limited), **Mr. K. R. H. James** (Wolverhampton Metal Company Limited) and **Mr. L. A. Jarvis** (Wigley Aluminium Limited).

In succession to **Sir Harry Jephcott,** the Lord President of the Council and Minister for Science has appointed **Sir Harold Roxbee Cox,** D.Sc.,

Ph.D., D.I.C., M.I.Mech.E., F.R.Ae.S., F.Inst.F., F.I.Ae.S., as chairman of the Council for Scientific and Industrial Research for five years from October 1 next. Sir Harold has been a member of the Council since 1957.

Whilst remaining as chairman and consultant to Keith Blackman Limited, **Mr. D. S. Woodley,** M.I.Mech.E., will be retiring from the office of managing director at the end of this month. **Mr. F. W. Goodge,** one of the present joint assistant managing directors, has been appointed managing director of the company from June 1, and **Mr. C. J. Atkins** will become assistant managing director from the same date.

Changes in the board of Tube Investments Limited have recently been announced as follows: **Lord Clitheroe** to be vice-chairman; **Sir Ben Lockspeiser** and **Sir Francis de Guingand** have resigned from the board—Sir Ben on reaching retirement age, and Sir Francis is returning to South Africa where he will continue to be in charge of the company's interests there. **Dr. J. M. Kay,** at present Professor of Nuclear Power at the Imperial College of Science and Technology at the London University, has been appointed to the board as director of research and development from July 1 next.

Development director of Albright and Wilson, **Mr. W. E. K. Piercy** has been appointed to the board of W. J. Bush and Company.

It is reported that **Mr. J. Fallon** has been appointed a director of Wellman Smith Owen Engineering Corporation.

As from May 1 last, **Mr. C. J. Buchanan-Dunlop** has been appointed manager of the Birmingham area sales office of Alcan Industries Limited in succession to **Mr. D. W. Taylor,** who is to take over management of the London area sales office later this year. For the past six months Mr. Buchanan-Dunlop has been assistant manager in Birmingham.

In succession to the late Mr. R. J. Harnott, **Mr. Kenneth Hand** has been appointed chief engineer of Alf'd Miles Limited.

While retaining his position as managing director of Pyrotenax Limited, **Mr. F. W. Tomlinson,** M.A., F.I.M., M.I.E.E., has been appointed deputy chairman of Murex Limited and Murex Welding Processes Limited.

A new export manager has been appointed by Geo. Salter and Company Limited. He is **Mr. D. J. Anelli,** who has been the company's export office manager for some seven years.

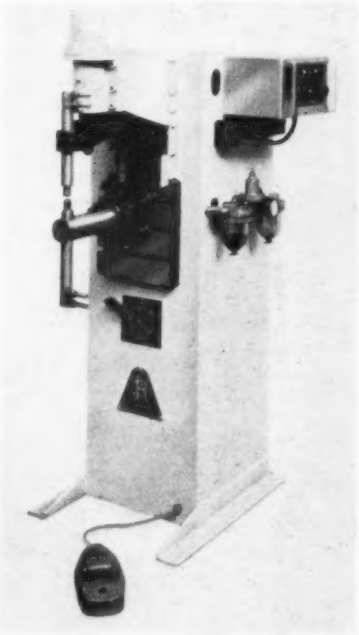
It has been announced that **Mr. T. Richmond** has been appointed to the board of the Titanic Steel Company Limited, a subsidiary of Samuel Osborn and Company Limited.

It is announced by the Benjamin Electric Limited that **Mr. M. D. Lippold** has been appointed Southern area manager.

At the annual general meeting of the Drop Forging Research Association, recently held in Sheffield, **Mr. R. Bennett** (Smethwick Drop Forgings Limited) was re-elected to the Council, and the following new councillors were elected: **Mr. H. G. Brown** (Firth-Derihon Stampings), **Mr. W. E. A. Redfearn** (English Steel Forge and Engineering Corporation), **Mr. D. B. Russell** (Smith and Sons, of Saltley), and **Mr. J. Shakespeare** (J. Shakespeare and Company Limited). At the Council meeting which followed, **Mr. J. H. Swain** (Stampings Alliance Limited) was elected chairman of the Council, and the following were co-opted to the Council: **Mr. R. K. Johnson** (Forgings and Presswork Limited) and **Mr. A. L. Stuart Todd** (National Association of Drop Forgers and Stampers).

Resistance Welding

UP to 250 progressive spots per minute are obtainable on light gauge material with a low capacity vertical sliding head, air-operated combined spot, projection and stitch welder, introduced by Standard Resistance Welders, Ltd., Maypole Fields, Cradley, Staffs. The rate of welding varies with the thickness of the material being welded.



Three sizes of this design are available at nominal ratings of 25, 35 and 50 kVA, at 50 per cent duty cycle.

Each welder is designed to give the requisite maximum electrode tip pressure when working on an air line pressure of 80 lb/in^2. For pressure regulation, a control valve is located between the air filter and lubricator.

The electrode arms can be moved through the horizontal plane. The bottom arm is bored at both ends to take an electrode, the bore at one end holding the electrode vertically, whilst the other end is set at an angle of 20 degrees.

Heat regulation is by means of a six-stage off-load rotary switch.

The transformer is of the S.R.W. high efficiency low impedance type, designed to operate on two phases of a 400/440 volt, 50 cycle, 3-phase electric supply.

A four-stage electronic timer working in conjunction with ignitron contactor or contactor switch, to control the welding cycle is provided. The welding cycle provides two ranges of cycles (3-20 and 15-100) for both squeeze and weld. Single or repeat operation is catered for.

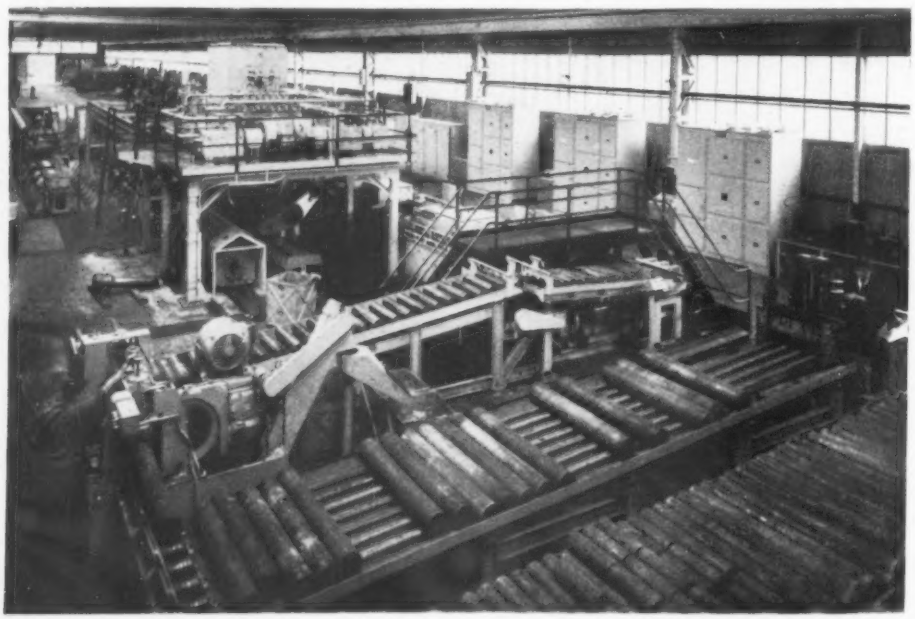
Mechanized Extrusion of Copper Alloys

Formally inaugurated by Sir William McFadzean, chairman and managing director of British Insulated Callender's Cables Limited, a new mechanized extrusion line, installed by Thomas Bolton and Sons Limited, was shown to visitors last Friday.

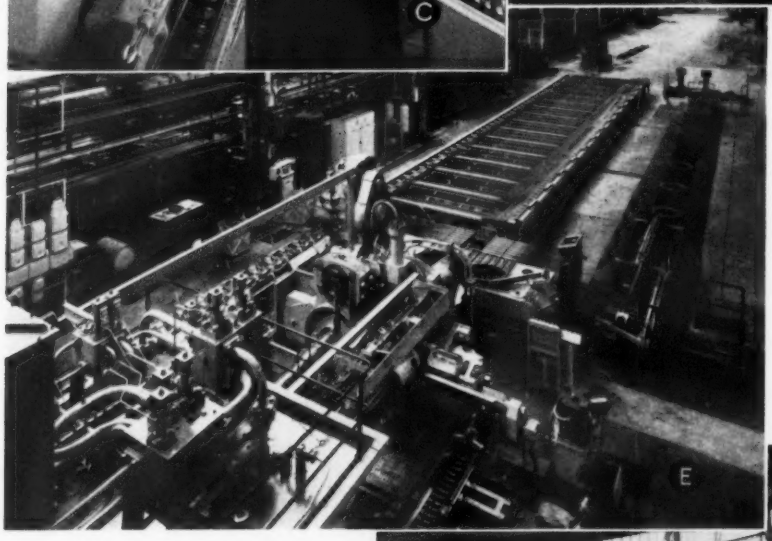
FOR the production of high quality rod, wire and sections, especially commutator sections, in a variety of copper alloys, one of the most up-to-date and highly mechanized extrusion presses in the country has recently been installed at the Froghall works of Thomas Bolton and Sons Ltd.

The extrusion press plant, designed and supplied by the Loewy Engineering Co. Ltd., of Bournemouth, comprises a 1,700 ton oil hydraulic extrusion press with three Loewy Magnethermic mains frequency induction heaters and completely mechanized gear for the supply of billets to the press and for removal of the extruded product.

Power to the press equipment is supplied from a sub-station at the end of the press building. Here, the incoming 11,000 V supply is fed to four 1,000 kVA transformers; three of these provide a secondary voltage of 3,300 V for the main pump motors and for the Magnethermic heaters, the fourth provides power at 415 V for the many auxiliary motors and other equipment. The whole of the sub-station equipment was supplied by The English Electric Co. Ltd.



Fork truck delivering billets to the roller conveyor prior to sawing to length



C—Magnethermic induction heaters

D—General view of extrusion press with coilers in position

E—General view of extrusion press from above

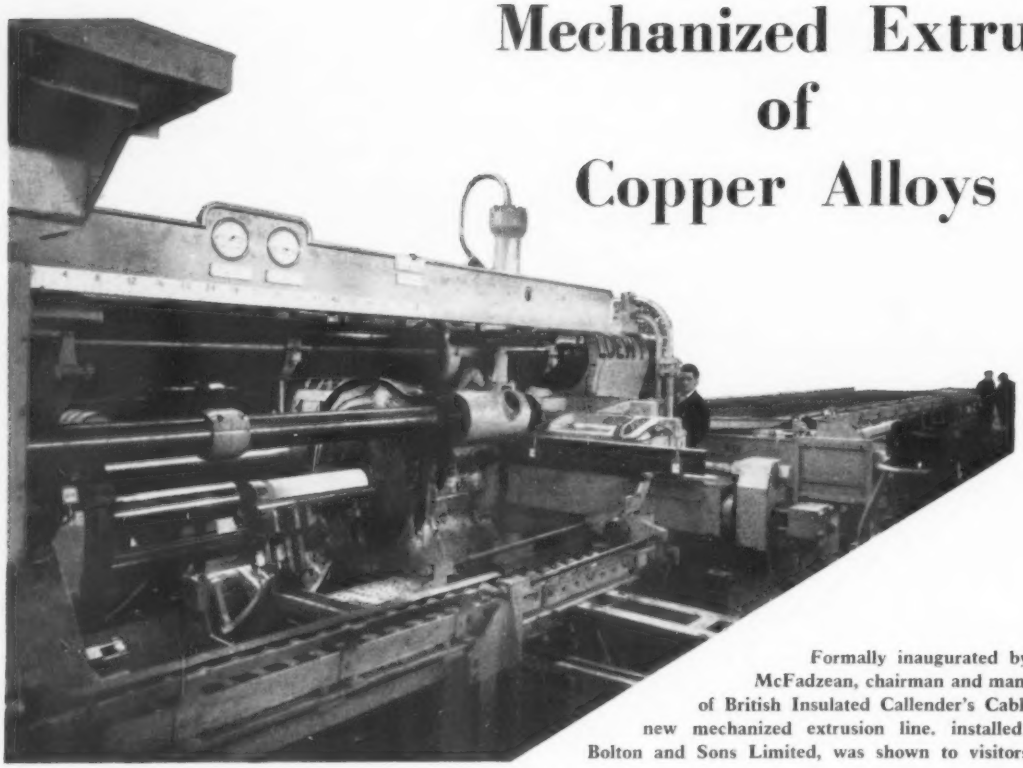
F—The two cooling conveyors

The horizontal extrusion press is of a special off-set three-column design, and incorporates a rotating die-holder enabling dies to be brought to an outer station for dressing or changing without any hold-up of production. The press is provided with both die-face and back-cut shears to allow for the utmost flexibility in the production of the widest range of products.

Hydraulic pressure is provided by ten Towler high speed oil pumps driven by two 250 h.p. 3,300 V Laurence, Scott motors. These, together with the electrically controlled oil hydraulic valves, are mounted on a platform above the press.

Fully automatic operation of all movements, from the acceptance of a cold billet to the final elimination of the discard and re-closing of

Mechanized Extrusion of Copper Alloys



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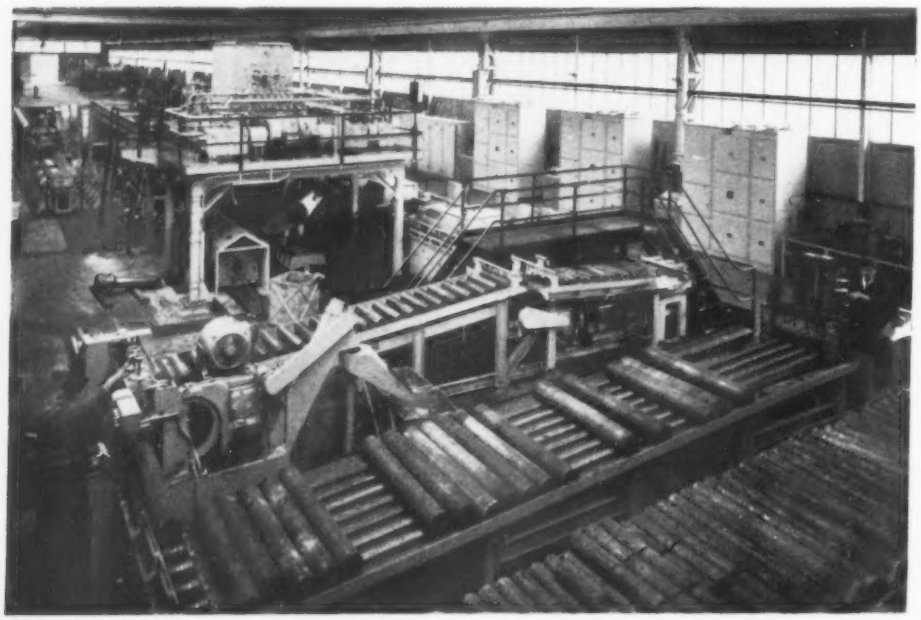
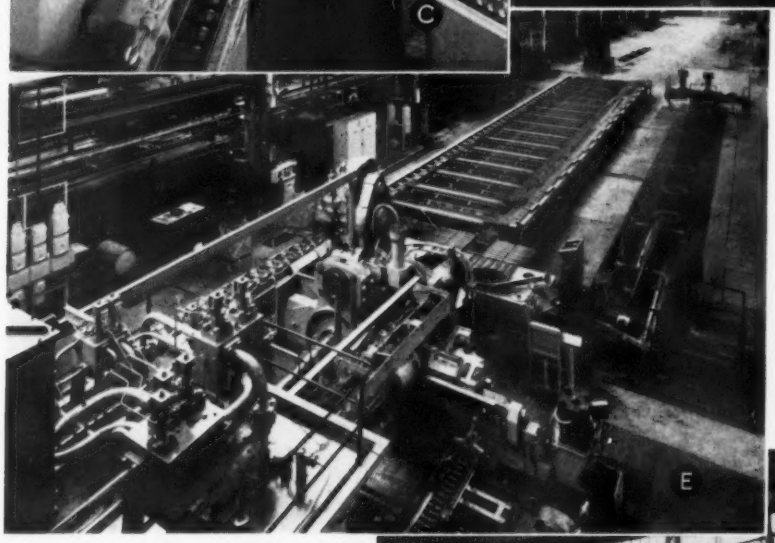


Fork truck delivering billets to the roller conveyor prior to sawing to length



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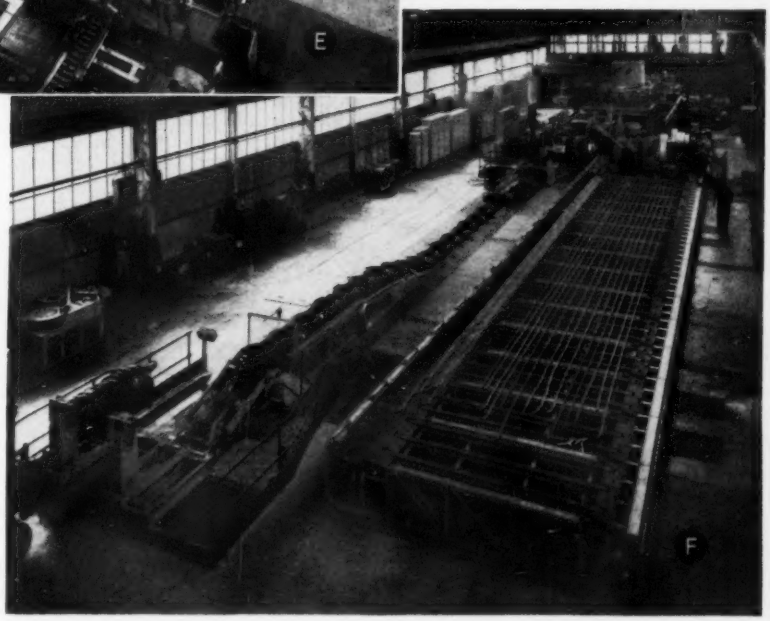

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Fully automatic operation of all movements, from the acceptance of a cold billet to the final elimination of the discard and re-closing of

Extruded coil being transferred from winder to conveyor

the press is provided in two stages. The first stage consists of discharging a hot billet from the appropriate heater, conveying it to a position in line with the container bore, placing a pressure disc behind it and reloading a cold billet into the heater coil. This cycle is completed by pressing a button on the main control desk, when the appropriate signal light shows that a billet is up to temperature. A second button initiates the extrusion cycle proper, which carries through all stages of extrusion, cutting off and discard ejection, ending only when the press is ready for the next hot billet. Twelve pre-set extrusion rates are provided to ensure that any size or type of product can be extruded under the most suitable conditions.

Manual control is, of course, available for testing purposes. This, like the choice of which shear is to be included in the automatic cycle, is controlled by a selector switch on the desk. The provision of so much automatic sequence switching not only reduces idle time to a minimum, thus allowing for a high production rate, but also makes for safety, as no movement can start until the previous one has been satisfactorily concluded. A guide to the completeness of the automatic features provided is given by the fact that the press control panels contain over a thousand switch contacts and that eighteen miles of cable were required in the installation.

The billet-handling gear on the incoming side of the press was designed and built by the Loewy Engineering Co. Ltd. Cast billets are delivered by fork truck on to three inclined ramps down which they roll to control gates beside the roller conveyor, which carries them to the saw. All billet movements, from the ramps to the magazine which feeds the Magnethermic heaters, are under push-button control from the sawyer's operating position. Sawing is done on a Russell 28 in. circular saw specially adapted to fit into the equipment, and any length can be cut between 10 in. and 27 in. Sequence switches ensure that the cut billets are fed to whichever heater is ready to receive them.

The three Loewy Magnethermic heaters have a maximum loading of 500 kVA each and are provided with Honeywell Brown temperature controllers calibrated up to 1,000°C. The designed capacity of the heaters is 6 tons of copper per hour raised to 850°C. Two sets of coils are available to suit billets of nominal diameters of 6 in. and 8 in. respectively. Secondary tappings at approximately $\frac{3}{4}$ in. intervals are available to allow for differing lengths of billets, but the five most commonly used are taken to a heavy selector switch and can be chosen at will. The air cylinders which control billet selection and movement can be operated by hand for testing purposes, but are normally under automatic control from the main operating desk. The desired billet temperatures are set on the heater control panels close by. Power factor correction is taken care of by three BICC capacitors, each of 1,000 kVAr capacity. A five-step switch allows correction to be adjusted according to the power input to the coils.

Completely mechanized handling gear is provided for both straight lengths and coils.

The run-out system for straight products was built by the Marco Conveyor and Engineering Co. Ltd. and consists of a roller track which can be driven at any speed required to match the extrusion rate and a cross transfer and cooling conveyor capable of handling lengths up to 75 ft. A dead plate is provided between the run-out rollers and the transfer conveyor so that initial cooling can take place while the material is fully supported throughout its length. A part of the dead plate is strengthened to allow for hammer straightening of large sections where this is appropriate.

After cooling, the material is delivered automatically to the shear line, which incorporates a 300 ton Cowlishaw Walker shear. For normal cutting to length, the shear makes single strokes when a pedal is depressed, but a selector switch makes continuous cutting available when required. An inching position provides for blade changing and cutting clearance adjustment. Lengths for cutting are fed through the shear to a stop by a powered roller conveyor under the control of the shearer. On the discharge side of the shear, a roller table receives the cut lengths. This incorporates throw-off arms allowing the lengths to be stacked in reception racks on either side of the shear line.

Vertical axis twin coilers of special design, with hydraulic variable speed drive, have been installed to handle either rod or strip. When dealing with rod, the centrifugal principle is used and the rod is simply poured into the coiler basket, but for strip coiling a special torque-limiting device is fitted, which enables pancake coils of controlled tightness to be wound. In both cases, the coiled material is lifted above the pegs by a rising bottom plate and pushed across to a transfer car.

The car takes the coils down to floor level, and automatically transfers them to a slat conveyor for cooling. After cooling, they are mechanically lifted on to a boom which, when full, is picked up by Stacatruc and the coils transferred to the storage area. The mechanized coil handling equipment was built by Moxey Ltd., of West Bromwich.

The whole plant has been designed as a fully mechanized automatic production unit to give the maximum output of high quality products.

Metal Finishing for the Electronics Industry

By J. DAWSON, F.I.M.

(*Concluded from* METAL INDUSTRY, 28 *April* 1961)

ONE of the most important developments in the electronics field has been the discovery and development of printed circuitry. This has posed many problems to the electroplating industry, and it is satisfactory to record that most of the problems have been overcome and a very useful technique developed.

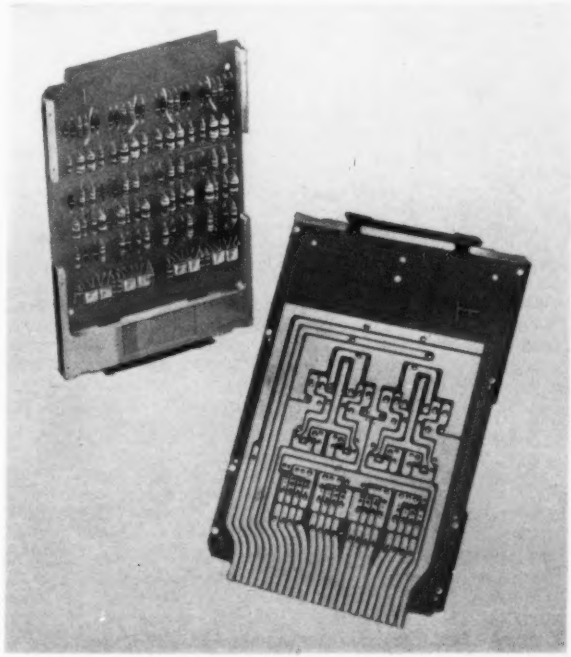
Essentially, the process consists of attaching copper foil to the surface of a plastics sheet, and then by some form of printing technique applying a resist to the surface and etching away parts of the copper to leave a desired circuit. In other words, a printed circuit is a series of electrically conducting paths on an insulated base.

The first problem set to the electroplaters was to produce a roughened copper foil which would hold a synthetic adhesive and, under suitable pressure and temperature conditions, be anchored securely to a plastics base. The production of such foil was interesting since usually one is trying always to get improved smoothness and brightness in deposits, but here was a case where the reverse properties were required.

There are, no doubt, many ways of producing sheet having the particular properties desired for this purpose. One way is to electroform on brass sheet, the surface of which has been treated in some manner to enable the deposit to be separated readily from it. The brass sheet is prepared by silver plating the surface and converting this to silver iodide by means of potassium iodide solution. The sheet thus treated is plated in an acid copper solution having a low acidity and using a current density of up to 100 amp/ft^2. The solution is agitated and plating continued for approximately 5 min. The deposit is then cleaned and washed in the usual manner and then transferred to a cyanide copper bath and plated using a current density of 50 amp/ft^2 without agitation.

In this manner, a uniformly rough surface on one side is produced and this, with the aid of a suitable adhesive, enables a good joint to be made to the plastics base. The whole system is then baked under suitable pressure and temperature conditions to produce a hard board surfaced with a smooth copper face on the one side. The plastics base can be paper, fabric, or glass fibre laminate with appropriate adhesives, the choice of base being determined by the conditions under which it will have to operate.

The smooth copper side of the sheet is coated with a resist put on either by silk screen printing or photographic processes. In the case of the latter, the copper surface is coated with a light-sensitive enamel. A film negative is placed on top of the enamel and the sheet exposed to a mercury vapour lamp. This converts the portion of the enamel which has been affected by the light to a hard, water-insoluble form. The portions of the enamel which have been masked by the negative and are, therefore, still water soluble, are carefully washed away, leaving a positive image of insoluble enamel which protects the underlying copper from the action of the etch used subsequently to remove the unwanted portion of the copper foil.



Typical printed circuit package for "Argus" process-control computer system

Using the silk screen process, an insoluble resist is applied directly to the copper foil through a silk screen negative and the copper not covered by the resist etched away directly.

Where a large number of identical circuits are required, this may seem to be a more attractive process, eliminating two stages as compared with the photographic method, but generally it is not possible to obtain fine lines or the high standard of accuracy obtained with the photographic process. In both cases, the resist material covering the printed circuit is removed by gentle abrasion with fine pumice.

The printed boards thus prepared have now a clean copper surface, and this has to be suitably protected from atmospheric corrosion. This is particularly necessary since a large number of soldered joints have to be made on the copper circuit. The choice of protective materials is limited, due primarily to the necessity of avoiding any attack on the laminate and the bond by, for example, plating solutions.

One suitable method found up to date has been to coat the entire circuit with a thin covering of chemically deposited gold from a proprietary buffered cyanide solution. The thickness of the gold deposit varies between 0·000005 in.-0·00001 in., but this appears to be sufficient to retain good solderability after storage in the atmosphere of an industrial district for up to two years.

Where the production warrants it, it is possible to continue straight from the pumice operation into a flux solution and then into a hot tinning bath, where the whole of the circuit gets covered with a thick coating of solder. Some of the printed circuits terminate in plug-in contacts, and these have to receive special treatment in order to stand up to the repeated insertions. This has led to the use of plated contact materials such as rhodium, palladium and gold, but, as mentioned previously, rhodium and palladium have their own particular difficulties, and the policy now is to use a harder type of gold deposited from an acid solution. Again the hardness should not be too great or the risk of pulling off the copper from the laminate will be very much increased.

A further development has been to

use circuits printed on both sides of a plastics laminate. Components on the one side have had to be joined with those on the opposite side and, initially, this was achieved by copper eyelets, which were punched through holes and made contact on both sides.

A more recent development has been to plate through the holes and thus obtain a continuous circuit from one side to the other. Various patents have been granted for suitable methods of performing this operation, which can consist of depositing metal chemically in the holes and then increasing the thickness of the deposit by plating in a conventional acid copper bath.

Electroforming

A further important development in plating which has been initiated by electronic industry demands is that of electroforming, to which reference was made earlier. It has enabled the production of complex shapes to be made without the use of prohibitively expensive tooling and, in some cases it has been proved to be easy to produce components required in electronic engineering, which are impossible to make by other techniques. For example, one of the principal needs is for the production of wave guides where it is necessary to have a very smooth surface inside a tube of varying cross-sections along its length.

Wave guides are used for carrying very high frequency currents (10 cm. or less) in the form of electromagnetic waves. The current flows along the surface of the tube, and for this reason it is essential to have the smooth surface to which reference has been made.

When simple straight shapes without re-entrants are required, it is usual to plate on to stainless steel mandrels which are ground and polished to a very high finish indeed. The high finish facilitates the removal or extrusion of the plated tube, and the thin film of chromic oxide present on the stainless steel mandrel gives poor adhesion and thus also assists in easy removal.

In this connection it is interesting to reflect how troublesome this oxide film could be when it was required to plate on stainless steel and yet, in this case, is a positive advantage.

The usual material deposited on the mandrel is copper, but it is not uncommon to plate first with a thin layer of silver and then build up with copper. The silver is of advantage in the electrical properties required.

The mandrels can be made from, for example, Perspex, which may be left in place or removed subsequently by organic solvents. In this case it was necessary to use special cleaning treatment and chemical metallizing on the Perspex prior to the conventional electroplating processes.

If the shape required is not a straight tube from which a mandrel can be withdrawn, then an expendable type of former is used. These are usually made from wax or plastics, which are both capable of being either melted or dissolved out from the copper or whichever metal has been deposited. The wax or plastics is usually coated with a chemical silver deposit using a modification of the Brashear mirror technique. In this, a solution of ammoniacal silver nitrate mixed with a sugar reducing solution is applied to the wax when the silver is deposited on the surface and acts as the conductor for building up with the appropriate metal. When the desired thickness, which can vary from a few thousandths up to $\frac{1}{4}$ in., is reached, the mandrel is then removed by one of the techniques mentioned.

In building up such heavy deposits it is essential to have the solution completely free from suspended metallic particles. If such particles carrying a positive charge are present they are capable of being deposited by the process of cataphoresis or simple solution movement on to the mandrel with dire results. Thus, it is essential to use cathode compartments and efficient anode-bagging coupled with continuous filtration.

The usual bath for this purpose is acid copper with slight modifications, but it is felt that the pyrophosphate type of solution will eventually replace it for this type of work.

While copper has proved the most popular metal for electroforming as applied to electronic projects, components have been made using nickel, iron, silver and even gold.

One particular point which requires mention is the internal stress which can be present in deposits of the thickness required in some waveguides. When these are attached to other components by either brazing or soldering, it may lead to release of stresses and consequent deformation of the internal surface of the waveguide. It is essential, therefore, to use the right solution and current conditions in order to cut the stresses to a minimum.

In these remarks it is not intended to convey that electroforming is a new technique, since it is probably one of the oldest in the electrochemical field. It has, however, been necessary to develop special techniques for use in electronic devices and this process now has a wide and important place.

Other Applications

While some of the major projects in which the electronics industry has influenced the metal finishing field have been mentioned, there are a number of smaller scale developments which are very interesting. For example, in the manufacture of aircraft instruments it is, of course, desirable and often essential to keep the weight down to an absolute minimum. For this reason, sealed instruments, for example, have to be assembled in aluminium containers, and this involves difficulties in soldering or jointing techniques. These difficulties are overcome by tinning the aluminium by electrodeposition. The usual method of preparation of the aluminium is used, that is the zincate process followed by copper and finally by tin. The tinned surface is then joined by conventional tin-lead solders. Unless the preparatory stages are carried out very carefully it is only too easy to get blistering at the soldering stage, and this can cause considerable trouble necessitating stripping to the base metal.

Again, for heat dispersion units in diode assemblies it is usual to use a honeycomb section made from aluminium for weight reasons. In order to obtain the maximum heat transfer the aluminium is plated with tin as described previously, then the various sections are riveted together and the whole assembly placed in an oil bath at 250°C. to allow the tin coatings to run together and produce a continuous line of metal through which the heat can be dispersed.

In the manufacture of certain diode assemblies, it is necessary to seal glass to metal and have a perfect joint which is completely airtight. The metal portion consists of an annular ring, which is copper plated to a thickness of 0·0003 in. in a Rochelle copper bath with a closely controlled *p*H. The glass preform is pushed into the inside of the ring, which it fits fairly closely. The assembly is then heated up to a temperature of 1,050°C. in an atmosphere of nitrogen, and the copper oxidizes very slightly and thus allows the glass to wet the surface.

On first sight this appears to be a fairly simple operation, but unless the copper has been plated with the utmost care, and the metal pre-treatment has been almost perfect, the copper tends to blister and thus ruin the seal. It is another case of a specialized technique being made necessary by the demands of the electronic industry.

This article can do little more than cover the fringe of the subject and there is a great deal of activity in plating applied to all types of electrical or electronic engineering devices. It has only been possible to outline some of the techniques which the plating industry has developed in order to meet the demands of the electronic age.

Carburised Chromium

HARDNESS of electrolytically deposited chromium can be increased by carburizing from an original 900-1,100 kg/mm^2 to 1,500-1,800 kg/mm^2, according to Russian work reported in *Masheriostroyeniye*. The wear-, corrosion-, and oxidation-resistance are also considerably improved. The investigation confirms that a similar carburization occurs in chromium-plated parts working under conditions of dry friction in combination with grey pearlitic iron. This explains the much lower wear rate shown by this combination compared with that of chromium plating working in conjunction with bronze or aluminium alloys.

Industrial News *Home and Overseas*

Diesel Tractor Shovel

At a demonstration last week of the range of **Yale and Towne** materials handling equipment, the new British-built Yale Trojan model 204 diesel tractor shovel was shown. A thoroughly versatile machine, this equipment has a lifting capacity of 12,000 lb. and may be fitted with a variety of tools, including pallet-type forks and crane hook.

This is the latest addition to the Yale range, which includes manually-operated pallet and platform trucks pedestrian controlled electric trucks in high lift fork, low lift pallet, platform and tractor models, and a wide variety of electric and diesel fork lift trucks. Most of these models can be equipped for handling any types of material from sand skips to coils, castings, ingots, or slabs.

Winder Equipment for South Africa

A repeat order, worth over £50,000, from the East Rand Engineering Company, of Johannesburg, has been received by **The General Electric Company Ltd.** for equipment to be used in the conversion of a winder from steam to electric drive. As in the case of the previous order, this converted winder will be installed underground at the Withok mine of the S.A. Lands and Exploration Company Ltd.

Anti-Corrosion Treatment

News from **Hellermann Ltd.** concerns Hellermann CRC 2-26, which is referred to as a simple but effective anti-corrosion and anti-moisture treatment for electrical and electronic equipment. This treatment is said to have the ability of penetrating pores, cracks or holes and displacing absorbed moisture. After driving the moisture out, a film is formed to prevent further contamination. It is understood that this film does not become brittle or crack, and is an excellent corrosion inhibitor for metallic surfaces.

Norwegian Aluminium Plant

Rectifier equipment for extensions to the aluminium smelting plant owned by Ardal og Sunndal Verk, in Norway, is in its final stages of manufacture in the Rugby works of **Associated Electrical Industries Limited.** Most of the equipment has been despatched, and erection at site, which is being supervised by A.E.I. engineers, started early in March last, is going well.

The contract for this equipment, which is rated at 108,000 kW, was obtained towards the end of 1959 by A.E.I. Heavy Plant Division in the face of severe competition from the continent.

Overseas Visitors

Scientists from the United Kingdom, U.S.A., Canada, U.S.S.R., France, Belgium, Sweden and Israel visited the Park Royal works of the Coating Division of **F. W. Berk and Co. Ltd.** during the first International Congress on Metallic Corrosion. They were shown one of the largest shot-blasting chambers in Europe (capable of treating the largest of road tankers), the company's extensive facilities for smaller shot-blasting and metal-coating contracts, advanced fluidization and spray techniques for plastics coatings, equipment for the application of Epikote linings and examples from the Berk range of metal spray pistols, shot-blasting machines, test instrumentation and ancillary equipment.

The delegates were welcomed to the works by Mr. C. H. Tanner, chairman, and Mr. F. A. Rivett, a director of the company. Their guides during the afternoon were Mr. H. E. Nesling (general manager), Mr. G. A. Curson (sales manager), and Mr. A. A. White (area sales manager), all of the Berk Coating Division.

A Joint Announcement

Information from **The General Electric Company Ltd.** and **Richardsons, Westgarth and Company Ltd.** is that they have decided to pool their resources for the design, development, sales and manufacture of heavy electricity generating and industrial power plant.

The object of this arrangement is to secure an increase in their share of the home and export markets, and at the same time to make the maximum possible use of their combined technical resources and production facilities. The two companies are now jointly in a position to build and equip, electrically and mechanically, complete modern power stations from within their own resources.

Site Shotblasting

Backed by over seventy years' shotblasting experience and the resources of the Staveley Coal and Iron Co. Ltd. group, the Birmingham firm of **R. J. Richardson and Sons Limited** is now operating a mobile site shotblasting service throughout the U.K. By utilizing the extensively varied experience gained from contract work in its shops since 1890, and making a substantial investment in mobile plant, it has been possible to ensure that consistent standards of finish can be obtained on site which are fully equal to those carried out in a permanent shotblasting installation.

The equipment employed is transported to sites on one 7-ton B.M.C. truck and one Bedford 7-ton four-wheel drive truck, each towing a 7-ton four-wheel trailer. The trailers, which are fitted with winches and low loading tail end gates, carry the power units for the equipment, the first trailer carrying a Leyland/Brush 90 kVA diesel generating set to provide electrical power for the operation of driers, recovery plant and dust suppression units, whilst the second transports a consolidated pneumatic type 600-RO-2 Rolls-Royce powered rotary "Power Vane" compressor which delivers 600 ft^3/min. of compressed air at a working pressure of 105 lb/in^2 for the operation of the Tilghman shotblasting equipment, this comprising shot feeding equipment, hoses, guns and recovery plant.

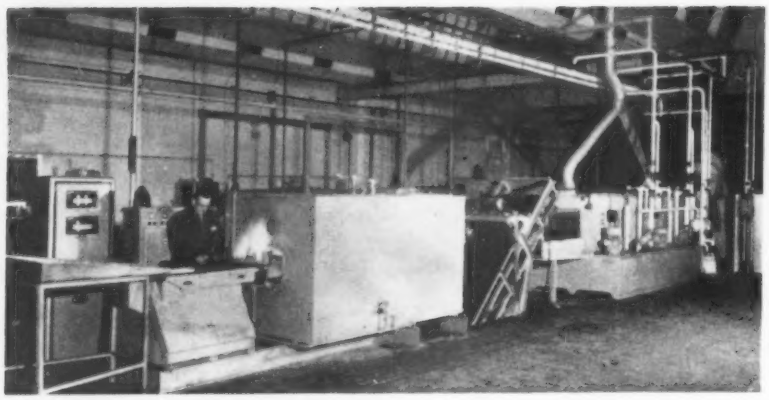
Fuel Efficiency Service

During the first quarter of this year the demands made upon the **National Industrial Fuel Efficiency Service** are stated to have reached the highest level ever. The value of orders placed with N.I.F.E.S. in the financial year 1960-61 is 21 per cent higher than in the previous year.

The number of detailed heat and power surveys completed in factories and commercial premises has now passed the 3,250 mark. These surveys are being devoted more and more to improving the heat-using processes in the factories, as well as improving the efficiency of boiler house plants.

Fuel savings (which on average amount to 20 per cent) have in many instances also been accompanied by increased output from the plants and better quality products. More than 900 of N.I.F.E.S. clients now have regular service agree-

Visitors to the laboratory of the Coating Division of F. W. Berk and Company Ltd. during the recently held International Congress on Metallic Corrosion in London



An Efco 50 kW shaker hearth furnace, quench elevator and washing machine recently installed in the Redditch works of Herbert Terry and Sons Ltd.

ments whereby their premises are regularly visited by the service engineers, who assist the firms to maintain their boiler houses, process plants and heating plants at the highest possible level of efficiency.

Heat-Treatment Plant

To maintain and improve the quality of their products, Herbert Terry and Sons Ltd. have installed new heat-treatment plant in their works at Redditch. Their extensive range of springs and presswork, varying considerably in size and complexity, is now being hardened in shaker hearth furnaces providing closed quench facilities.

One of the new furnaces is rated at 50 kW and has a hearth 18 in. wide with a heated length of 5 ft., arranged in two independently controlled zones, each with its own automatic temperature-indicating controller. This furnace has an oil quench tank fitted with oil cooling and circulating equipment.

The other furnace is rated at 20 kW and has a hearth 12 in. wide with a heated length of 2 ft. 6 in. These shaker hearth furnaces, the endothermic generator and the Alnor dewpoint meter were supplied by **Efco Furnaces Ltd.**, and the automatic washing machine was manufactured by **Electro-Chemical Engineering Company Ltd.**

Industrial Finishing

On Monday next, May 8, the first **International Industrial Finishes Exhibition** will open at Earls Court, London, and will remain open until May 11. The exhibition will incorporate metal pretreatments, paints and their applications, electroplating, galvanizing, metal colouring, anodizing, vitreous, shotblasting, vacuum deposition, instrumentation, and all the necessary ancillary equipment and processes for the finishing of industrial products.

Rumour Denied

A rumour which has been circulating stating that their works were damaged in the recent fire which occurred in Cambridge has been denied by **Pye Process Heating Division**. It is understood that the fire was in another section of the works and has not in any way upset the production of dielectric or induction heating equipment.

On Show

Among the short-term feature exhibitions which are being held at The Engineering Centre in Birmingham is that which will be provided by **Welding Improvements Ltd.** on Tuesday, May 16, to Thursday, May 18. The latest techniques in low heat metal forming will be demonstrated, including welding, bronzing, surfacing and soldering.

Industrial Films

A new industrial film catalogue is announced by the **G.B. Film Library.** The catalogue is a comprehensive guide to the visual aid material available from the library which can be used for training and education purposes by industry, and which has previously been included in separate publications. The aim has been to provide one complete catalogue covering all industrial needs.

For ease of reference the catalogue is divided into four sections: films for industrial training, including the salesman-training series; technical educational films; sponsored (free hire) films, and technical filmstrips. In this last category will be details of two new sound filmstrips. Full details may be obtained from the Library at 1 Aintree Road, Perivale, Middlesex.

Aluminium Project in Rhodesia

According to news from Salisbury, preliminary talks have been held there regarding the establishment of a Rhodesian aluminium smelting industry, and representatives of Aluminium-Industrie-A.G., of Zurich, are said to have made some investigations.

Heat-Resisting Alloys

At the Imperial Hotel, Birmingham, from May 9 to 11, **Henry Wiggin and Company Ltd.** will hold an exhibition of heat-resisting alloys, featuring the Nimonic series, the Nimocast series, Inconel, Incoloy and Incoloy DS. It will demonstrate properties and applications of these alloys by diagrams and animations, also a comprehensive range of exhibits of components and subassemblies will be displayed in which Wiggin materials are used.

The exhibition will be supplemented by lectures on high-temperature problems given by the company's technical staff and supported by film showings. The exhibition will be moved the following week to the Hotel Metropole, Leeds, where it will remain from May 16 to 18.

Brazilian Beryllium Project

Stockholders at the annual meeting of the Standard Beryllium Corporation were told last week in New York that the company plans to use a new flotation process in a new concentration mill to be constructed on the Boa Vista property in Brazil.

Scheduled for completion early in 1962, the output of the new mill is expected to supply about 15 per cent of the total anticipated increase in the world's consumption of beryl in 1962. A company official said that world beryl consumption was approximately 9,500 tons in 1960 and is expected to be from two to three times that amount in 1962. Boa Vista, the official said, contains proven and probable beryl reserves of approximately 350,000 tons on a 1,700 acre site approximately 200 miles north of Rio de Janeiro.

Aluminium in Germany

It has been announced by Aluminiumwerke Goettingen G.m.b.H. that during the next two years an annual capacity of 25,000 tons of aluminium sheet and strip will be added to its semis producing plant. Aluminiumwerke Goettingen is one of the two German subsidiaries of Aluminium Limited of Canada (Alcan). During the last two years the West German aluminium market has rapidly expanded, and is likely to expand further. Alcan is carrying out its expansion programmes in order to maintain its share in the market.

Contract from Australia

It has been announced by **Schloemann Aktiengesellschaft** that they have been awarded a contract by the Broken Hill Pty. Co. Ltd., of Australia, for the construction of a complete 39 in. blooming and slabbing mill. Ingots up to 6 tons and slabs up to 10 tons are to be rolled, and the planned annual capacity is 1,750,000 tons.

New Swiss Smelter

It is reported from Zurich that Aluminium - Industrie Aktiengesellschaft of Chippis has recently started the building of a new aluminium smelter at Steg, in the Valais. The new plant will commence operations in 1962 and will have an initial capacity of some 20,000 tons. In 1960 the company produced some 35,180 tons of crude aluminium at its Chippis works—15 per cent more than in 1959.

Nickel Prospecting in Japan

Japanese nickel refineries are said to be actively seeking new nickel ore supply sources in Indonesia, Rhodesia and Australia to lower their production costs in view of the approaching liberalization of imports of nickel ingots. The Sumitomo Metal and Mining Company, a leading non-ferrous metal manufacturer, said it planned to despatch its engineers resident in Australia to Tasmania this month for nickel prospecting. The company is also planning, jointly with the Shimura Kako Company, another nickel refinery, to develop nickel mines in Southern Rhodesia, and has sent a survey group to that country.

Five nickel producers in Japan, including Sumitomo and Shimura, are considering a plan to establish jointly a company to carry out prospecting and development of nickel mines and other mineral resources in the Celebes, Indonesia, the Sumitomo Company added.

Automation Equipment for Russia

Special nucleonic instruments, developed in Britain, will soon be helping the spread of automation in Russia's steel industry. It is reported that **Davy and United**

Instruments Ltd. have signed a contract with Stankoimport, of Moscow, for the supply of eight transmission gamma ray thickness gauges to be installed in Russian steel mills. These gauges use a radioactive isotope as the measuring medium and are capable of continuous measurement to extremely fine limits of accuracy on anything from white-hot steel plate to cold strip. They perform this measurement automatically without any necessity for touching the material being rolled.

The value of the contract is stated to exceed £90,000, and it has been negotiated through the Trade Delegation of the U.S.S.R. in the U.K. Delivery will take place in the first quarter of 1962. As is customary with Davy-United radiation instruments of this type, the radioactive source and detection device will be supplied by **Isotope Developments Limited**.

Silicone Rubbers

A further two products have been added to its range of "Silcoset" silicone rubbers by **I.C.I. Nobel Division.** The first, "Silcoset" 103 is a white solvent-free paste that cures at room temperature to a resilient silicone rubber after addition of the appropriate curing agent. This rubber is recommended for high-temperature sealing, patching, caulking, potting, and the encapsulation of sensitive electronic assemblies. Dissolved in a solvent it can be sprayed, and cloth may be coated by spraying or dipping.

"Silcoset" 104 is thixotropic, with flow properties that make application from a caulking gun satisfactory. It can be readily bonded to primed metal surfaces and is especially suited for sealing, patching and caulking when a room temperature cure is necessary.

Four curing agents are available for these rubbers. Curing agent "A" is a general purpose agent, "B" is comparatively slow acting and useful when long pot life is needed, "C" is a non-toxic agent, and "D" is very fast acting.

New Chemistry Building

On Monday last, the second major new building in the vast development programme of the University College of Swansea was officially opened by Sir Alexander Todd, D.Sc., F.R.S. In this new building will be housed the Department of Chemistry, and it will consist of three major units : a wing each for teaching and research laboratories, linked together into an integral unit by a central spine accommodating lecture theatres, main stores and central services. On the roof of the research wing, provision has been made for a small laboratory to deal with hazardous experiments.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell 190 tons to 9,927 tons, comprising London 4,254, Liverpool 3,665 and Hull 2,008 tons.

Copper stocks rose 115 tons to 15,057 tons, distributed as follows: London 600, Liverpool 12,332, Birmingham 100, Manchester 1,975 and Hull 50 tons.

Lead duty-free stocks fell 15 tons to 8,046 tons, comprising London 8,031 and Glasgow 15 tons, while in-bond remained unchanged at 3,868 tons, all supplies being in London.

Zinc duty-free stocks fell 124 tons to 3,996 tons, while in-bond stocks rose 391 tons to 1,116 tons, comprising London duty-free 2,653 tons and in-bond 1,116 tons. Liverpool duty-free 1,253 tons and in-bond nil tons, and Glasgow duty-free 90 tons and in-bond nil.

1,700-ton Extrusion Press

On Friday of last week, the official opening of the Loewy press, which has been installed at the Froghall works of **Thomas Bolton and Sons Limited,** was performed by Sir William MacFadzean.

The visitors were welcomed by Mr. F. Waine, chairman of the company, and in performing the opening ceremony, Sir William made some references to the history of Thomas Bolton and also gave some details of the new 1,700 ton semi-automatic horizontal Loewy press.

A fully illustrated description of this new press is given on page 356 in this issue of METAL INDUSTRY.

British Trade Fair

To be held in Stockholm next year from May 18 to June 3, the **British Trade Fair** has the support of the British and Swedish Governments and is being sponsored by the Federation of British Industries and the Export Council for Europe.

The Fair will be held in the St. Erik's Fairground, which is sited near the centre of Stockholm and is surrounded by gardens and woods. At this Fair will be displayed a wide range of goods of all kinds which British industry has to offer to Sweden and other Scandinavian markets.

Machinery, chemicals, scientific instruments and vehicles are among the examples of goods for which there are many openings in the country.

Trade with Hungary

According to reports from *Comtel*, the Board of Trade has released full quota details of the trade agreement signed in Budapest last week. The agreement covers the twelve months to January 26, 1962. Under the agreement, Hungary will import aluminium ingots and semi-manufactured aluminium products to the value of £460,000. Britain will import mineral manufactures to the value of £194,000 from Hungary. In addition, Hungary will import tin to the value of £90,000, cadmium to the value of £25,000, and manganese to the value of £10,000 through U.K. merchants.

A Die-Casting Merger

An agreement between **Metal Castings Ltd.,** of Worcester, and the Doehler-Jarvis Division of the National Lead Company of America promises considerable expansion of the die-casting facilities at the Worcester works.

The agreement with Doehler-Jarvis, who are the largest trade manufacturers of large pressure die-castings in the world, means that Metal Castings will receive the full benefit of their technical knowledge and experience, and the assistance of their large research department. Doehler will supply machines of a size capable of producing the larger castings envisaged, and send over experts on loan to give what help is necessary. As part of this arrangement, and subject to the consent of the shareholders, the National Lead Company will acquire a majority interest in Metal Castings Limited from the present shareholders. Under this arrangement the company will be known as Metal Castings Doehler Ltd.

Five new machines are being built by Doehler-Jarvis for installation in an entirely new building which is to be erected at Worcester, and increased toolroom and other facilities are being planned. These extensions are additional to those already initiated by Metal Castings, who began the erection of a new £60,000 foundry and research department some months ago.

Although the new arrangements may necessitate some changes on the board of directors, Mr. F. W. McConnell will continue as chairman and Mr. R. D. Turner as managing director.

U.S. Tin Consumption

Total tin consumption in the United States increased 4 per cent in 1960, according to the Bureau of Mines, United States Department of the Interior. Consumption was 80,560 long tons (51,530 primary and 29,030 secondary), compared with 77,375 long tons in 1959 (45,835 primary and 31,540 secondary). Three items—tinplate, solder, and bronze and brass—consumed more than 80 per cent of the tin in 1960 and 1959. Consumption of tin in tinplate (the leading use of primary, which took 65 per cent of the 1960 total) increased to a record quantity of 7,960 long tons, despite sharply curtailed tin-mill operations during the closing months of 1960.

Industrial receipts of tin were 80,330 long tons (5 per cent less than 1959), of which 63 per cent was primary tin. "Straits" brand comprised about 62 per cent of primary receipts.

Consumers' stocks (including pig tin in transit in the United States to plants) decreased 4 per cent. Pig tin stocks dropped 5 per cent, whereas other raw materials remained virtually unchanged. Tinplate mills, holding nearly 65 per cent of plant stocks of pig tin in the United States, decreased inventories 3,400 long tons. At the end of the year, pig tin stocks at other industrial plants were 1,440 tons more.

Anaconda Aluminium Production

It has been announced by the Anaconda Aluminum Company that its Columbia Falls, Montana, reduction plant has returned to 100 per cent operations with the reactivation of 30 idle reduction cells. The Columbia Falls plant has been producing at approximately 87½ per cent of capacity since July 1959. The reactivation brings the plant up to its newly rated production capacity of 65,000 tons annually.

Industrial Relations

What is the role of the Minister of Labour in industrial relations between management and workers, and under what powers does he act? What proportion of the working population of Great Britain have their wages and conditions of employment fixed by joint negotiation? What principles operate in the settlement of agreements between management and workers? What are the functions of shop stewards and their relationship to negotiating machinery? The answers to these, and many other questions on industrial relations in Great Britain, can be found in the *Industrial Relations Handbook*, compiled by the Ministry of Labour, a revised edition of which was published on Monday last.

The handbook is a manual for all who have a practical concern with industrial relations. It does not advocate particular practices or procedures, but sets out essential facts about the organization of employers and workers in Great Britain, explains how they negotiate, and about what, how differences are settled, what part is played by the Government, and how relationships at the place of work may be adjusted.

Metal Market News

THE dramatic change for the better in the situation in the French Republic, following on the putsch in Algeria, imparted a note of strong optimism to the stock market, and this was reflected on the Metal Exchange, where a bullish atmosphere prevailed, copper being the outstanding metal with a turnover above the average. In this country, it would not seem that consumers have evinced much interest, but buying by the Continent has been reported. The threat of a strike at the Mufulira mine was a bull point and, of course, the dock strike, which virtually paralysed much of the Port of London, probably caused some enquiry for prompt metal. Very bullish advices, too, were received from the United States, where it was reported that there were persistent reports of an increase in the price of electrolytic copper, possibly to 30 or even 31 cents. The strength of the London market is certainly affording every excuse for an upward adjustment of the American quotation, but it was not thought last week that this would occur before May 1. In view of the sharp rise in values in Whittington Avenue and in New York, it is being generally assumed that all the curtailment schemes will be dropped, even though the March figures showed that world stocks of copper are still increasing.

Last week opened with news of a 25 tons decrease in L.M.E. stocks to 14,942 tons, and later on came a report that there was a threat of strike action at Mufulira. But the mainspring of the advance was provided by the reports from New York that there was every reason to suppose that an advance would come both in the custom smelters' quotation and that of the producers also. As always happens, the two markets reacted on each other and the big advance seen in London on Thursday brought about a sharp jump in the Comex quotation. On Friday, however, the tone was a shade easier, and the afternoon closing quotations were below the best. In all, the turnover added up to some 13,250 tons, without Kerb dealing, and final prices were £234 15s. 0d. for cash and £236 for three month. Earlier in the week the contango narrowed to 10s., but, fortunately, this did not persist. On balance, cash gained £6 and three months £5 10s. 0d. A little of the steam went out of the market when it was known that the strike ballot at Mufulira had been cancelled. It is understood that a fair amount of business was done in physical metal with the Continent, but U.K. consumers are not thought to have bought much.

The situation on the old metal side remains very tight, for supplies are as short as ever, and demand is well maintained. In the States, the situation is similar, perhaps even worse, and prices are high relative to new metal. Japan is still an avid buyer of copper, and this, as much as anything else, is keeping the U.S. market bare. In the other metals, tin lost £3 on balance in both positions to close at £843 cash and £849 three months on a turnover of 1,400 tons. Stocks fell by 66 tons to 10,117 tons. In lead, there was a turnover of 7,500 tons, the close being £68 5s. 0d. and £69 5s. 0. for cash and forward. This meant gains of 17s. 6d. and 12s. 6d. Some 6,350 tons of zinc changed hands, both positions gaining 10s. to close at £84. There was a fairly marked fall in Metal Exchange stocks of 231 tons to 4,845 tons.

Birmingham

Metal manufacturers have healthy order books for the first half of the year, and long-term prospects are encouraging. Light metal and engineering industries in the Midland area are fully employed. The production of cars is increasing, and plans for increasing output are going forward. At the monthly meeting of the Midland Regional Board for Industry, Major C. R. Dibben, chairman, said that though the revival in car sales appeared to be largely in the home market, there were hopes of increased exports in the next four or five months as a result of successes at recent international motor shows. The market for machine tools has expanded and order books are much heavier.

Iron and steel activity is maintained and is supported by the expansion in the requirements of the engineering industries situated in Birmingham and the Black Country. In addition to the greater demand for sheets for the motor trade there is a heavy call for structural steel of all descriptions to be delivered to new building sites locally and further afield. Plate mills are well situated for business with tank and boilermakers. The consumption of pig iron in foundries continues to increase. Re-rolling firms are getting ample supplies of semi-finished steel from British steelworks.

New York

Copper futures eased on week-end profit-taking, influenced by the lack of a price advance in physical copper last Friday. The undertone in physical copper continued firm. Trade sources indicated that custom smelters are waiting for producers to move on a price rise, and producers are waiting for the custom smelters to move. Meanwhile, little copper was available for May, producers setting aside June copper for their regular customers. Scrap copper was steady and quiet. Tin was quiet and steady. Lead and zinc sales were reported fairly good.

The Commerce Department estimates that copper consumption by U.S. fabricators will increase 10,000 tons in the second 1961 quarter, over the first three months of the year. The Department said the increased consumption will be divided equally between brass and wire mills, the brass mills intake increasing from 120,000 to 125,000 tons, while the wire mills will use 205,000 tons of copper, compared with 200,000 tons previously. At the same time, the Department said, producers' and fabricators' stockpiles will increase by 20,000 tons, while U.S. exports of refined copper scrap and alloy ingots will decrease 30,000 tons in the second quarter.

The Crucible Steel Company, a producer of titanium, expects consumption of the metal this year to exceed the 1960 level by about 10 per cent. Mr. R. C. Durstein, Crucible's titanium product manager, said January titanium mill production was below the December figure, but this should not be interpreted as indicating a down trend. He noted that 85 per cent of U.S. titanium production was for defence purposes, but the civilian market appeared to be growing.

Holland

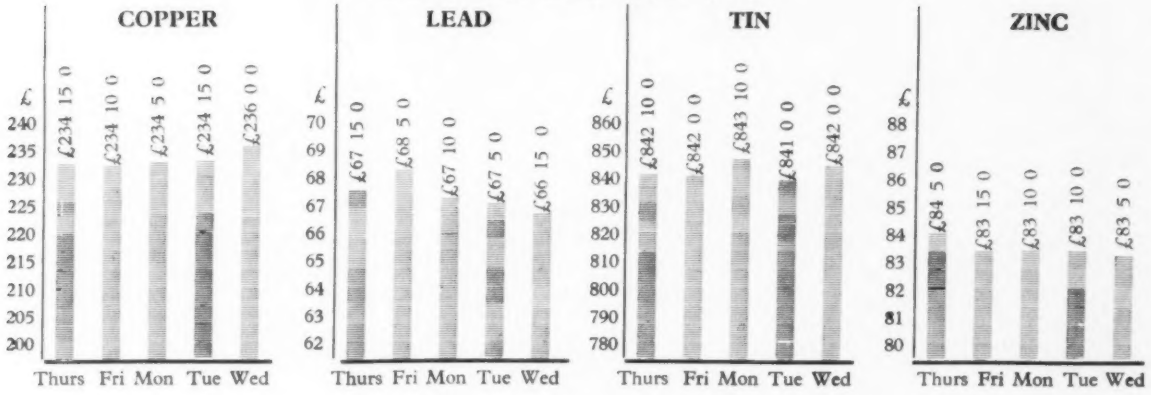
The establishment of a federation for the metal and electrotechnical industry, uniting 1,237 enterprises employing more than 340,000 workers, was announced at The Hague last week. The Federation has been established by five employers' organizations—the Catholic Employers' Association for the Metal Industry (K.V.W.M), the Metal Union (Metaalbond), which is an employers' metal industry association, the Association for Dutch Electro-Technical Factories (F.O.E.G.I.N.), the Association of Metal Industries (V.M.I.) and the Association of Protestant Industrialists in the Dutch Metal Industry (V.P.C.M.).

It was announced that the purpose of the new federation is to achieve co-operation, socially and economically, between organizations and enterprises in the metal industry and the electro-technical industry. The chairman of the new federation, Mr. W. Van Osselen, who is chairman of the V.M.I. and a representative of a Culemborg metal factory (Gispens Fabriek voor Metaalbewerking N.V.), said that these two branches of industry achieved the record turnover of 10,600,000,000 guilders last year.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 27 April to Wednesday 3 May 1961



Primary Metals

All prices quoted are those available at 2 p.m. 3/5/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	„	237	10	0
Antimony Metal 99%	„	230	0	0
Antimony Oxide Commercial	„	194	10	0
Antimony White Oxide	„	212	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	0
Calcium	„	2	0	0
Cerium 99%	„	15	0	0
Chromium	„		6	11
Cobalt	„		12	0
Columbite	per unit		8	10	0
Copper H.C. Electro	ton	236	0	0
Fire Refined 99·70%	„	235	0	0
Fire Refined 99·50%	„	234	0	0

		£	s.	d.
Copper Sulphate	ton	78	0	0
Germanium	grm.		—	
Gold	oz.	12	10	10¾
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	66	15	0
Magnesium Ingots	lb.			
99·8%	„		2	2½
99·9+%	„		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		5	6
Alloy Ingot, AZ91X		1	1⅓-2	1½
Manganese Metal	ton	280	0	0
Mercury	flask	67	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.	20	0	0
Osmiridium	„		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	„	30	5	0
Rhodium	„	46	0	0
Ruthenium	„	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	7⅛
Tellurium Sticks	lb.	2	0	0
Tin	ton	842	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	83	3	9
Dust 95/97%	„	125	0	0
Dust 98/99%	„	131	0	0
Granulated 99+%	„	108	3	9
Granulated 99·99+%	„	123	3	9

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg≏£/ton	**Canada** c/lb≏£/ton	**France** fr/kg≏£/ton	**Italy** lire/kg≏£/ton	**Switzerland** fr/kg≏£/ton	**United States** c/lb≏£/ton
Aluminium		26.00 210 12	2.43 179 11	370 216 1	2.50 210 5	26.00 207 4
Antimony 99.0			2.80 206 18	520 303 13		32.50 259 0
Cadmium			16.25 1,200 17			160.00 1,275 4
Copper						
Crude				440 256 19		
Wire bars 99.9						
Electrolytic	31.75 232 1	28.25 228 16	3.24 239 8		2.85 239 13	29.00 231 6
Lead		10.00 81 0	.96 70 18	165 97 7	.80 67 5	11.00 87 13
Magnesium						
Nickel		70.00 567 0	9.00 665 2	1,180 689 2	7.50 630 15	74.00 589 15
Tin	118.50 866 2		12.01 887 10	1,590 928 11	10.30 866 4	107.87 859 14
Zinc						
Prime western		12.25 100 4 0				
High grade 99.95		12.85 104 17 0				
High grade 99.99		13.25 107 6 0			1.05 88 6	
Thermic			1.23 90 17			
Electrolytic			1.31 96 16	189 110 7		13.00 104 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 3/5/61

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10 .... „	221	0	0
B.S. 1490 L.M.11 .... „	215	0	0
B.S. 1490 L.M.12 .... „	223	0	0
B.S. 1490 L.M.13 .... „	216	0	0
B.S. 1490 L.M.14 .... „	224	0	0
B.S. 1490 L.M.15 .... „	210	0	0
B.S. 1490 L.M.16 .... „	206	0	0
B.S. 1490 L.M.18 .... „	203	0	0
B.S. 1490 L.M.22 .... „	210	0	0

Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton	171	0	0
B.S. 1490 L.M.2 .... „	174	0	0
B.S. 1490 L.M.4 .... „	180	0	0
B.S. 1490 L.M.6 .... „	181	0	0

*Aluminium Bronze			
BSS 1400 AB.1..... ton	250	0	0
BSS 1400 AB.2..... „	258	0	0

*Brass	£	s.	d.
BSS 1400-B3 65/35 .. ton	181	0	0
BSS 249 ..... „		—	
BSS 1400-B6 85/15 .. „	229	0	0

*Gunmetal			
R.C.H. 3/4% ton .... „		—	
(85/5/5/5) LG2 ..... „	226	0	0
(86/7/5/2) LG3 ..... „	236	0	0
(88/10/2/1) ..... „	289	0	0
(88/10/2/½) ..... „	298	0	0

*Manganese Bronze			
BSS 1400 HTB1..... „	199	0	0
BSS 1400 HTB2..... „	216	0	0
BSS 1400 HTB3..... „	235	0	0

Nickel Silver				
Casting Quality	12%	„	250	0 0
„ „	16%	„	265	0 0
„ „	18%	„	305	0 0

*Phosphor Bronze			
B.S.1400P.B.1.(A.I.D. released) ..... „	316	0	0
B.S. 1400 L.P.B.1 „	247	0	0

**Average prices for the last week-end.*

Phosphor Copper	£	s.	d.
10% ..... ton	256	0	0
15% ..... „	258	0	0

Phosphor Tin			
5% ..... „	923	0	0

Silicon Bronze			
BSS 1400-SB1 ..... „	292	0	0

Solder, soft, BSS 219			
Grade C Tinmans ... „	385	10	0
Grade D Plumbers .. „	308	0	0
Grade M ..... „	424	0	0

Solder, Brazing, BSS 1845		
Type 8 (Granulated) lb.		—
Type 9 „	„	—

Zinc Alloys				
BSS 1004 Alloy A .. ton	116	13	9
BSS 1004 Alloy B.... „	120	13	9
Sodium-Zinc ..... lb.		2	7

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium				
Sheet 10 S.W.G. lb.		2	10½
Sheet 18 S.W.G. „		3	0½
Sheet 24 S.W.G. „		3	3½
Strip 10 S.W.G. „		2	10½
Strip 18 S.W.G. „		2	11½
Strip 24 S.W.G. „		3	1
Circles 22 S.W.G. „		3	4½
Circles 18 S.W.G. „		3	3½
Circles 12 S.W.G. „		3	2½
Plate as rolled ..... „		2	10
Sections ..... „		3	4
Wire 10 S.W.G. .... „		3	1½
Tubes 1 in o.d. 16 S.W.G. ..... „		4	4

Aluminium Alloys				
BS1470. HS19W.				
Sheet 10 S.W.G. „		3	3
Sheet 18 S.W.G. „		3	5½
Sheet 24 S.W.G. „		4	1
Strip 10 S.W.G. „		3	3
Strip 18 S.W.G. „		3	4½
Strip 24 S.W.G. „		4	0½
BS1477. HP30M.			
Plate as rolled ..... „		3	1
BS1470. HC15WP.			
Sheet 10 S.W.G. „		4	3
Sheet 18 S.W.G. „		4	8½
Sheet 24 S.W.G. „		5	8½
Strip 10 S.W.G. „		4	4
Strip 18 S.W.G. „		4	8½
Strip 24 S.W.G. „		5	4½
BS1477. HPC15WP.			
Plate heat treated ... „		3	10½
BS1475. HG19W.			
Wire 10 S.W.G. „		4	2
BS1471. HT19WP.			
Tubes 1 in. o.d. 16 S.W.G. ..... „		5	5
BS1476. HE19WP.			
Sections ..... „		3	4
Split tube			
19 S.W.G. (¼") ..... „		4	2
20 S.W.G. (⅛") ..... „		3	11
21 S.W.G. (⅛") ..... „		4	1
22 S.W.G. (¼") ..... „		4	11
Welded tube			
14 to 20 S.W.G. (sizes ½" to 1½") .... „	3/10½ to 5/8½		

Brass			
Tubes ..... lb.		1	10½
Brazed Tubes ..... „		3	3
Drawn Strip Sections „		3	2½
Sheet ..... ton	203	0	0
Strip ..... „	203	0	0
Extruded Bar ..... lb.		2	1
Condenser Plate (Yellow Metal)..... ton	192	0	0
Condenser Plate (Naval Brass) ..... „	204	0	0
Wire ..... lb.		2	8½

Beryllium Copper			
Strip ..... „	1	4	11
Rod ..... „	1	1	6
Wire ..... „	1	4	9

Copper			
Tubes ..... lb.		2	3½
Sheet ..... ton	270	0	0
Strip ..... „	270	0	0
H.C. Wire ..... „	286	15	0

Cupro Nickel			
Tubes 70/30 ..... lb.		3	6½

Lead			
Pipes (London) ..... ton	107	0	0
Sheet (London) ..... „	104	15	0
Tellurium Lead ..... „	£6 extra		

Nickel Silver			
Sheet and Strip 10% .. lb.		3	10½
Wire 10% ..... „		4	3½

Phosphor Bronze			
Wire ..... „		4	2½

Titanium (1,000 lb. lots)		
Billet 4½" to 18" dia..... lb.	47/-	48/-
Rod ½" to 4" dia..... „	85/-	53/-
Wire ·036"-232" dia.... „	159/-	99/-
Strip ·001" to ·048"..... „	350/-	68/-
Sheet 8'×2', 20 gauge „	73/-	
Tube, representative average gauge ..... „	198/-	
Extrusions ..... „	90/-	

Zinc			
Sheet ..... ton	121	15	0
Strip ..... „	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 2/5/61.

Aluminium	£
New Cuttings	141
Old Rolled	114
Segregated Turnings	83

Brass	
Cuttings	165
Rod Ends	148
Heavy Yellow	141
Light	135
Rolled	154
Collected Scrap	140
Turnings	141

Copper	
Wire	213
Firebox, cut up	210
Heavy	208
Light	205
Cuttings	216
Turnings	190
Braziery	184

Gunmetal	£
Gear Wheels	208
Admiralty	208
Commercial	192
Turnings	187

Lead	
Scrap	57

Nickel	
Cuttings	—
Anodes	555

Phosphor Bronze	
Scrap	192
Turnings	187

Zinc	
Remelted	76
Cuttings	66
Old Zinc	46

Financial News

W. Canning and Co.

Net profit, 1960, £268,158 (£251,440) and dividend 9½d. per 5s. unit (9d. and distribution 4·9d. net). Fixed assets £1,031,267 (£896,600 — market value of properties at year-end approximately £1,400,000 against book value of £734,209. Trade investments £145,308 (£134,805), current assets £4,106,878 (£4,095,626) and liabilities £1,842,314 (£1,819,586).

Killinghall Tin

Profit, before tax, 1960, £30,421 (£25,524), and dividend 1s. 3d. per 5s. share (same). Current assets £293,849 (£292,774), liabilities £50,444 (£48,687). Returns were very disappointing during quarter to March 31, 1961. Recently, there has been some slight improvement in rate of output, but dividend prospects for current year are not encouraging, says chairman.

Kennecott Copper

The Kennecott Copper Corporation has reported that first-quarter 1961 sales and other income totalled 119,299,000 dollars, compared with 119,008,000 dollars in the corresponding period a year ago. Earnings per share, however, fell to 1.46 dollars from 1.65 dollars.

The company said the lower earnings reflected the fact that the increased volume of shipments was more than offset by lower copper prices. Kennecott said the demand from Europe, where the output of their Chilean division is sold, has remained strong, and United States business is improving. Sales have recently exceeded production sufficiently so that in order to meet demands it was necessary late in April to resume domestic operations on a seven-day week basis.

Bolivian Tin

Final details of the proposed 48 million dollars' triangular loan for the development of Bolivia's national mining industry under a three-year plan were being ironed out in Washington this week. The credits are to be granted by the United States Government, the Inter-American Development Bank and West Germany (through the firm of Saltzgitter Machinen Aktiengesellschaft).

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Jones Separators Limited (687798), Sea View Connor Downs, Hayle, Cornwall. Registered March 24, 1961. To carry on business of manufacturers of and dealers in wet magnetic separators, mineral dressing and mining machinery, etc. Nominal capital, £100 in £1 shares. Directors: George H. Jones and Mrs. Ethel Jones.

Presswork and Fabricators Limited (687809), 3 Frederick Road, Edgbaston, Birmingham, 15. Registered March 24, 1961. To carry on business of manufacturers of and dealers in ferrous and non-ferrous castings, mouldings, etc. Nominal capital, £5,000 in £1 shares. Directors: John H. H. Bradburn and William G. Richardson.

Grove Polishing Co. Limited (688083), 95 Crofton Road, S.E.5. Registered March 28, 1961. To carry on business of metal workers, etc. Nominal capital, £1,000 in £1 shares. Directors: Gilbert F. Carter and Mrs. Gladys Carter.

A. E. Harrison (Scrap Metals) Limited (688123), 1 Alexandra Road, Balby, Doncaster. Registered March 28, 1961. Nominal capital, £10,000 in £1 shares. Directors: Albert E. Harrison, senr., Mrs. Mona Harrison and Horace Harrison.

J. J. Ellis Limited (688140), 117 Dudley Road West, Tividale, Tipton. Registered March 28, 1961. To take over the business of a metal and scrap merchant carried on at Tipton by J. J. Ellis, etc. Nominal capital, £10,000 in £1 shares. Directors: Jas. J. Ellis and Clarice Ellis.

Hendon Metal Works Limited (688629), 176 The Broadway, West Hendon, N.W.9. Registered April 4, 1961. To carry on business of welding engineers, etc. Nominal capital, £1,000 in £1 shares. Directors: Wm. C. Carpenter, Elvet J. Morgan, Ernest W. Clark and Raymond J. Carpenter.

Whiston Metals Limited (688873), 17 Whiston Road, E.2. Registered April 5, 1961. To carry on business of machinery and metal merchants, etc. Nominal capital, £5,000 in £1 shares. Directors: Wm. C. Woods and Mrs. M. M. Woods.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

France (new francs per kilo):

Electrolytic copper scrap	(£219.9.0) 2.97
Heavy copper	(£219.9.0) 2.97
No. 1 copper wire	(£205.8.0) 2.78
Brass rod ends	(£166.9.0) 2.25
Zinc castings	(£71.13.0) 0.97
Lead	(£66.10.0) 0.90
Aluminium	(£125.12.0) 1.70

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£178.2.0) 305
Lead, soft, first quality	(£80.0.0) 137
Lead, battery plates	(£44.19.0) 77
Copper, first grade	(£219.0.0) 375
Bronze, commercial gunmetal	(£183.19.0) 315
Brass, heavy	(£152.17.0) 260
Brass, light	(£140.3.0) 240
Brass, bar turnings	(£152.17.0) 260
Old zinc	(£64.4.0) 110

Japan (Yen per metric ton):

Electrolytic copper	(£—)	293,000
Copper wire No. 1	(£—)	267,000
Copper wire No. 2	(£—)	252,000
Heavy copper	(£—)	252,000
Light copper	(£—)	220,000
Brass, new cuttings	(£—)	206,000
Red brass scrap	(£—)	215,000

West Germany (D-marks per 100 kilos):

Used copper wire	(£204.19.0)	225
Heavy copper	(£204.19.0)	225
Light copper	(£182.4.0)	200
Heavy brass	(£132.1.0)	145
Light brass	(£95.13.0)	105
Soft lead scrap	(£52.16.0)	58
Zinc scrap	(£52.16.0)	58
Used aluminium unsorted	(£81.19.0)	90

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for Feb. 1961 have been issued by the Aluminium Industry Council as follows (in long tons):—

Virgin Aluminium	
Production	2,151
Imports	21,454
Despatches to consumers	33,469
Secondary Aluminium	
Production	10,740
Virgin content of above	1,263
Despatches (including virgin content)	10,152
Scrap	
Arisings	10,915
Estimated quantity of metal recoverable	8,080
Consumption by:	
(a) Secondary smelters	10,890
(b) Other uses	1,257
Despatches of wrought and cast products	
Sheet, strip and circles	13,603
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	3,957
(b) Tubes (i) extruded	289
(ii) cold drawn	603
(iii) formed strip	—
(c) (i) Wire	1,443
(ii) Hot rolled rod (not included in (c) (i))	63
Forgings	331
Castings: (a) Sand	1,685
(b) Gravity die	3,911
(c) Pressure die	1,400
Foil	2,063
Paste	267

LIGHT METALS STATISTICS IN JAPAN
(December 1960)

Classification	Production	Shipment	Stock	Export
Alumina	31,578	23,126	20,775	0
Super purity Al	143	62	661	0
Primary Al	11,819	12,476	6,552	0
Secondary Al	4,776	4,674	816	0
Wrought products (Al and its alloy)	12,873	12,616	3,737	1,227
Plate, sheet and strip	8,835	8,723	2,558	1,070
Foil	801	846	258	
Rolled and extruded shape	1,900	1,950	276	
Forgings	59	—	—	—
Electric wire	1,192	1,002	645	152
Powder, flake and paste	86	95	—	—
Casting	6,520	—	—	—
Sand and permanent mould	3,499	—	—	—
Die	3,021	—	—	—
Sheet products	2,598	2,813	1,361	102
Primary Mg	224	225	28	—
Secondary Mg	230	206	428	—
Mg casting	32	—	—	—
Sponge Ti	188	217	998	196
Super purity Al (Jan.)	133	122	672	—
Primary Al (Jan.)	11,981	12,657	5,877	0

THE STOCK EXCHANGE

Tendency Turned Irregular

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 1 MAY	+ RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation	33/-		11	9	6 13 3	33/-	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/-		NIL	4	NIL	1/-	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries	43/6	—6d.	15	15	6 18 0	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	67/6	+1/-	10	15‡	2 19 3	67/6	45/-	51/3	29/-
4,795,000	1	Birmid Industries	103/-	+3/6	20	20D	3 17 9	103/-	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	36/-	+6d.	17½QT	12½	3 4 9	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/-		5	5	7 2 9	14/4½	13/9	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/-	+3d.	6	6	7 1 3	17/6	16/9	20/-	17/1½
500,000	1	Bolton (Thos.) & Sons	52/6	+3/9	12½	10	4 15 3	52/6	37/6	43/-	36/-
300,000	1	Ditto Pref. 5%	14/-		5	5	7 2 9	14/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6%	17/-		6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	62/-	+2/-	13½	13½	4 7 3	62/-	50/4½	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd., Ord.	37/-	+1/9	16	16	2 3 3	37/-	26/3	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	17/6xd		15‖	25 + *2½C‡	4 10 6	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/4½		NIL	12½	—	1/7½	1/-	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	28/6		12	10	8 8 6	29/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	4/3		15	15	7 1 3	4/2½	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	77/6	+6d.	20	15	5 3 3	77/6	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	171/3	+1/3	30‡	20	1 15 0	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	25/9	+1/3	20	17½	3 17 9	25/9	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	48/-	+2/-	15	15	6 5 0	52/3	45/-	56/9	45/-
1,155,000	1	Evered & Co.	45/-		10B	10φ	2 19 6	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	36/-xd	—6d.	10	10	5 11 0	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	63/6	—1/6	25	20	3 18 9	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	20/6	—3d.	13	11½	3 3 6	21/1½	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	27/6xrtsxd	—6d.	22½	25¶	4 1 9	30/-	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries	43/-	—1/3	19L	16	3 6 3	44/9	34/9	41/9	33/-
696,780	10/-	Greenwood & Batley	29/-xcap	+4/-	30W	30	5 3 6	29/6	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	14/1½	—3d.	*20‡	*17½	3 10 9	14/4½	12/-	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	20/-		7	7	7 0 0	20/3	20/-	23/6	22/-
1,612,750	5/-	Heenan Group	16/3	+9d.	13	15	4 0 0	17/1½	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries	79/-	+4/-	13½	11½	3 8 9	75/7½	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/6	+6d.	5	5	6 9 0	15/9	14/10½	18/-	15/4½
29,196,118	**	International Nickel	140	+6	$1.60	$1.50	1 17 6	140	104	105	84½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/6		5	5	6 18 0	14/10½	14/-	16/6	14/6
6,000,000	1	Ditto Ord.	63/9	+6d.	12	12D	3 15 3	64/3	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	21/3	+3d.	17½	17½E	8 4 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	13/9	+1/4½	12	10	3 10 0	13/9	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord.	63/9	+4/3	17½F	15F	5 9 9	63/9	53/6	71/6	57/3
1,530,024	1	Ditto A. Ord.	62/6	+3/6	17½F	15F	5 14 3	62/6	53/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	16/-		20‖	20‖	6 10 0	18/6	14/-	18/6	13/4½
50,628	6	Ditto (7½% N.C. Pref.)	5/6		7½	7½	8 3 9	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	92/9	+3/9	12M	13B	2 3 6	93/6	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/6		50	50	11 15 3	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	41/-		12½	10	6 2 0	41/-	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3		6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A.	71/3	+3/-	13	12	3 13 0	71/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref.	15/6		5½	5½	7 2 0	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	48/3	+9d.	22½J	15	5 0 0	48/3	39/9	45/-	35/3
585,000	5/-	Ratcliffs (Great Bridge) Ord.	16/-xd		10	10R	3 2 6	16/6	16/-	17/-	14/9
195,000	5/-	Ditto 8% Max. Ord.	4/9	—3d.	8	—	8 8 6	5/-	4/10½	5/3	5/-
1,064,880	10/-	Sanderson Kayser	37/6		35‡	25	4 13 3	38/-	33/9	40/3	27/7½
3,400,500	Stk. (5/-)	Serck	17/6	+3d.	12½	17½GD	3 11 3	18/3	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	66/-		15	15	4 11 0	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/6		5½	5½	7 2 0	15/9	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	80/6	+3/3	14	20	3 9 6	85/6	72/3	140/3	63/10½
41,000,060	Stk. (£1)	Vickers	36/-xd	—1/-	10	10	5 11 0	37/3	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref. 5%	14/6		5	5	6 18 0	14/9	12/7½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6		*5	*5	7 5 0A	20/7½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	80/6	+6d.	13½	25	3 8 3	81/-	64/6	94/-	63/-
7,109,424	Stk. (£1)	Westinghouse Brake	41/9	—6d.	11	10	5 5 3	42/3	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting	13/-	+1/6	35	30	5 7 9	13/-	9/-	13/10½	8/1½
591,300	5/-	Wolverhampton Metal	28/6	—1/-	32½	27½	5 14 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/4½	—1½d.	15	20‡	8 11 6	4/6	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	8 17 9	13/7½	13/6	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/3		40	30	7 12 6	5/6	4/6	5/4½	4/-

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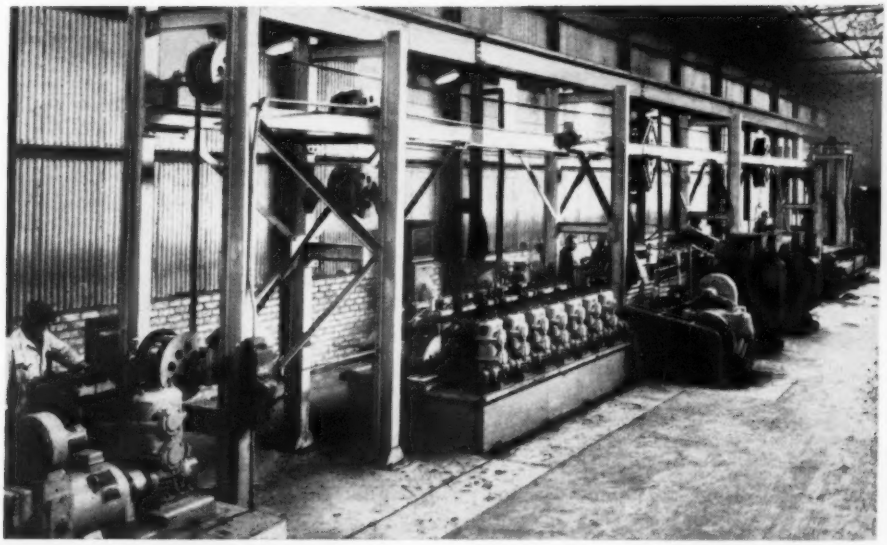

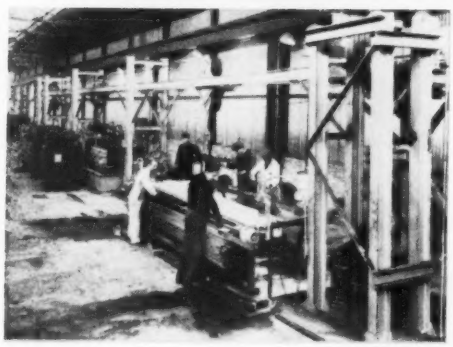

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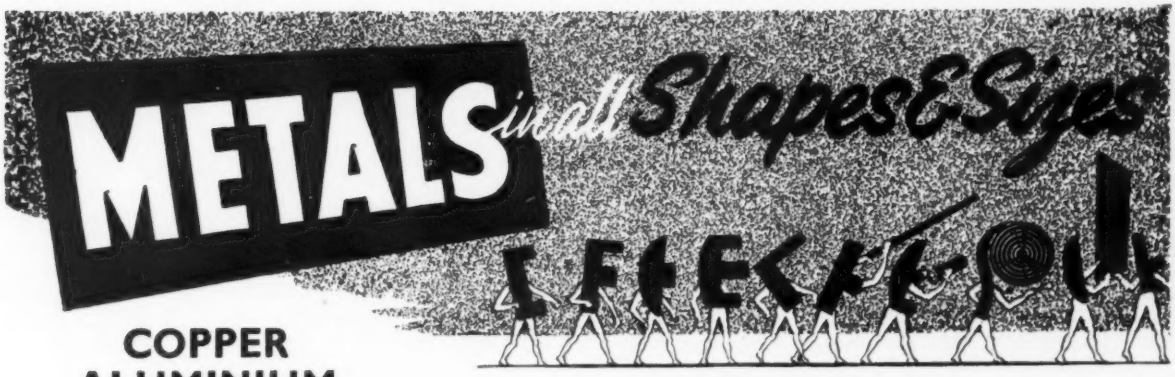

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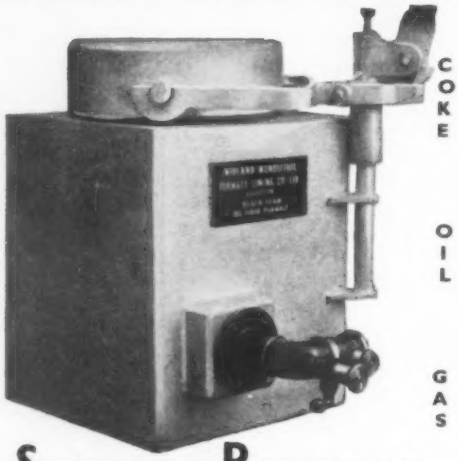

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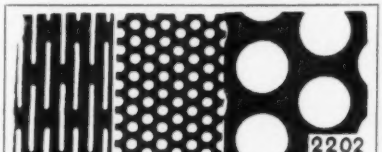
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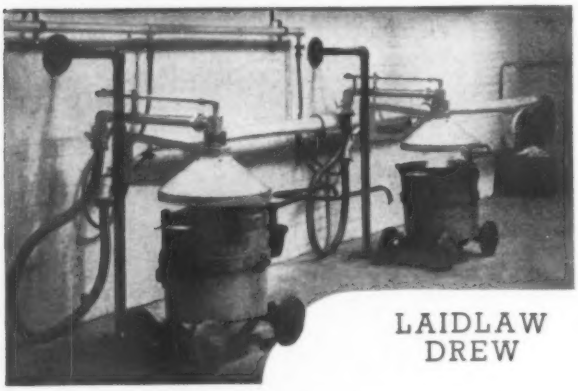

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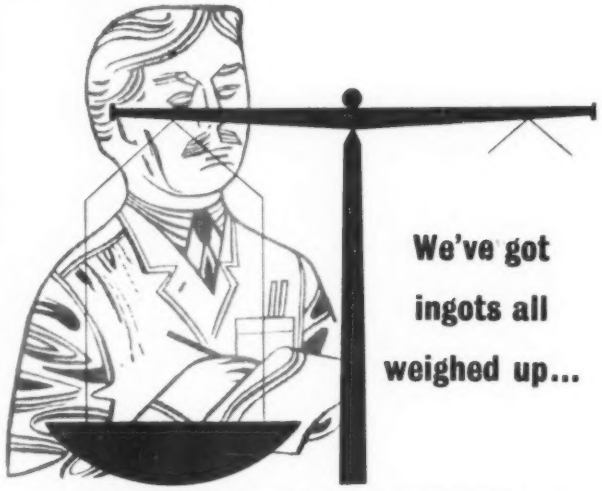

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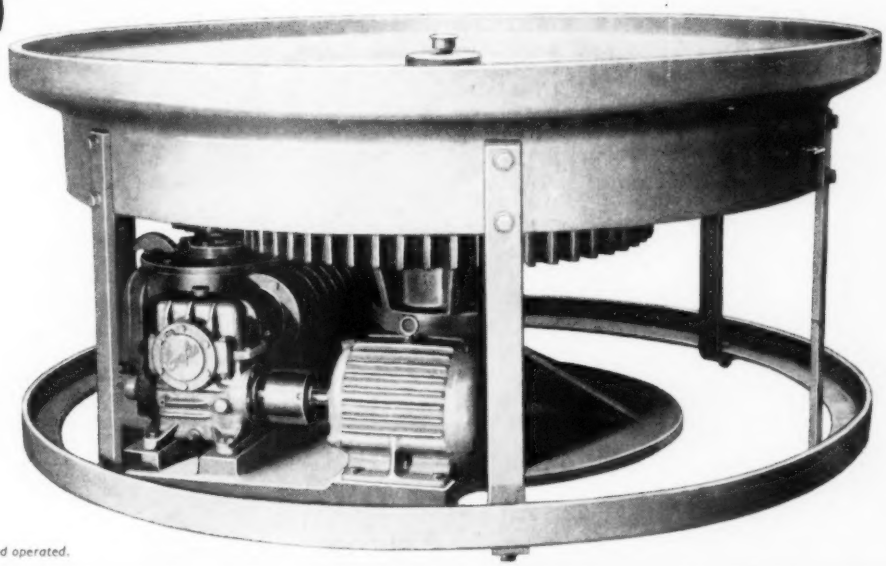

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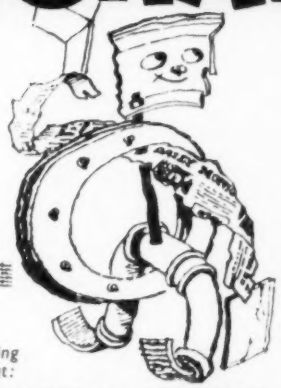

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